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List of Acronyms

ACEC	Area of Critical Environmental Concern
ANR	Approval Not Required
BMP	Best Management Practice
CWA	Clean Water Act
CSO	Combined Sewer Overflow
CGWS	Community Groundwater Supply
CSWS	Community Surface Water Supply
DEM	Massachusetts Department of Environmental Management
DEP	Massachusetts Department of Environmental Protection
DFWELE	Division of Fisheries, Wildlife and Environmental Law Enforcement
DPW	Department of Public Works
EOEA	Massachusetts Executive Office of Environmental Affairs
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FRCOG	Franklin Regional Council of Governments
FWCD	Franklin Conservation District
GIS	Geographic Information Systems
GW	Groundwater Source
MassGIS	Massachusetts Geographic Information Systems
MEPA	Massachusetts Environmental Policy Act
MGD	Million Gallons per Day
MGL	Massachusetts General Laws
MHD	Massachusetts Highway Department
MREC	Millers River Environmental Center
MRPC	Montachusett Regional Planning Commission
MRWC	Millers River Watershed Council
MWI	Massachusetts Watershed Initiative
NHESP	Massachusetts Natural Heritage and Endangered Species Program
NPDES	Massachusetts Pollution Discharge Elimination System
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service
NTNC	Non-Transient, Non-Community water supply
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
RCRA	Resource Conservation and Recovery Act
SDWIS	Safe Drinking Water Information System
SW	Surface Water source
TMDL	Total Maximum Daily Load
TNC	Transient, Non-Community water supply
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UST	Underground Storage Tank
WWTP	Wastewater Treatment Plant
WCCD	Worcester County Conservation District
303(d)	List of Impaired Waters
319	Nonpoint Source Pollution Implementation Section of The Clean Water Act
604(b)	Watershed Assessment Section of the Clean Water Act

I. Introduction

The watershed is the land area that contributes water to a stream or common set of streams and rivers. These stream systems form an interconnecting network of waterways that drain a watershed. As water moves through the watershed towards the drainage point in the form of runoff it transports a variety of materials (e.g., silt, clay, organic matter and nutrients) and deposits them elsewhere in the watershed or discharges them to receiving surface waters. This deposition of material in surface waters is considered non point source pollution.[1]

Non Point Source Pollution comes from a wide range of activities, most of which directly relate to non-sustainable land use. Residential and commercial land development in the Millers River Watershed is proceeding at a fast pace in many rural towns. This urbanization is threatening environmental resources within the watershed.

During urbanization, pervious spaces including vegetated and open forested areas are converted to land uses that usually have increased areas of impervious surface, thereby possibly increasing runoff volumes and pollutant loadings. While urbanization may enhance the use of property under a wide range of environmental conditions, urbanization typically results in changes to the physical, chemical, and biological characteristics of a watershed. Vegetative cover is removed from the land and cut-and-fill activities that enhance development potential of the land occur. For example, if natural depressions that pond water are graded to a uniform slope, the volume of runoff is increased during a storm event. As population densities increases, there is a corresponding increase in pollutant loadings generated from anthropogenic activities. These pollutants in the form of debris and sediment laden runoff could potentially enter surface waters without treatment and may alter the watershed.[2]

As urbanization occurs, changes to the natural hydrology of the watershed are inevitable. The hydrologic and hydraulic changes that occur in response to site clearing, grading and, the addition of impervious surfaces are most problematic due to increased runoff volumes. Described further, impervious surfaces such as rooftops, parking areas, roads, sidewalks decrease the infiltrative capacity of the ground and result in greater increased runoff volumes and degradation of environmental resources (Schueler, 1987).

The Massachusetts Executive Office of Environmental Affairs (EOEA) created the Massachusetts Watershed Initiative in 1993 to address pollution and to protect and restore environmental quality to our waterways. The initiative works toward measurable improvement in water and environmental quality, protection and restoration of wildlife habitats, improved public access to and balanced use of waterways, improved local capacity to protect water resources, and shared responsibility for watershed protection and management.

The Millers River Watershed is one of 27 major watersheds in Massachusetts. A Watershed Team, made up of key stakeholders such as business leaders, citizens, and representatives from non-profit organizations, municipalities, and regional state and federal agencies, coordinates the activities to integrate regulatory permitting and water usage decisions at the watershed level. The Team's goal is to improve water quality conditions and provide a framework for the restoration and protection of the basin's natural resources using a watershed approach.

The watershed team operates on an on-going five-year cycle. In the first year, the team concentrates on outreach and information gathering. The team assesses the availability of watershed condition data and contacts watershed residents. In the second year, the team conducts monitoring and other research methods to build on water quality and quantity data. Assessment analysis of water impairment commences in the third year. In year

[1] Leopold, L.B., M.G. Wolman, and J.P. Morgan, 1964, *Fluvial Processes in Geomorphology*, Freeman, San Francisco, CA: 522 pp., and Commonwealth of Massachusetts, Department of Environmental Management, *Massachusetts Forestry Best Management Practices Manua,*. 1995.

[2] Leopold, L.B. *Water, Rivers and Creeks*, University Science Books, California, 1997, 179 pp., and Schueler, T.R., *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's*, Metropolitan Washington Council of Governments, Washington D.C., 1987

four, the team develops plans for implementing solutions to water quality problems, addressing permit modifications, writing grant proposals, and devising mitigation programs. In year five, the team evaluates its progress and develops a course of action for the next five-year cycle.

In March of 2000 the Montachusett Regional Planning Commission was awarded a Section 604(b) Water Quality Management Planning Grant from the Commonwealth of Massachusetts Department of Environmental Protection to conduct an assessment of Potential Non Point Source (NPS) Pollution in the Millers River Watershed. The purpose of the project is to identify potential non-point sources of pollution and create a Watershed Action Plan that will incorporate Millers River Watershed Basin Team and Millers River Watershed Council goals. The intent is to create a solid information base to guide future governmental and private actions to reduce non-point source pollution, and to improve and ensure a high level of water quality in the Millers River Watershed.

A. Non-point Source Pollution

Non Point Source (NPS) Pollution is a direct result of man's interaction with his environment. It is related to land uses, water uses, and natural drainage systems. It is difficult to identify and measure since it has no clearly discernible point of entry to the watershed. Changes in land use that remove trees, create impervious surfaces and alter natural drainage patterns affect the rate and amount of rainwater that washes across the landscape instead of being moderated by the tree canopy and absorbed by the surface soils. Development reduces the capacity of the land to absorb rainwater, leaving the ground vulnerable to its erosive power. Many land use activities contribute pollutants to the soil and water through wastewater discharges and manufacturing processes. Regardless of the point of entry (land, air, or water), pollutants eventually move through the ecosystem through the actions of the hydrologic cycle.

Non-point source pollution is prevalent throughout society, in the forms of automobile leaks, smoke stack emissions, animal wastes, agricultural applications of fertilizers and pesticides, household cleaning agents washed into septic management systems, or underground storage tank leaks. A variety of land-use activities can contribute to NPS pollution. Some of the potential contributors are listed below:

Agriculture - Surface water impacts can be caused by erosion and sedimentation of croplands, grazing lands, and feedlots; poor agricultural waste management practices; alteration of wetlands and watercourses; and loss of riparian vegetation. Ground water contamination can result from excessive use of fertilizers, poor waste management practices, use of approved pesticides for enhanced crop production and leaking underground fuel storage tanks.

Atmospheric Deposition – Nitrogen and sulfur compounds are released into the atmosphere from combustion and chemical processes, and form acids that enter surface waters through fallout, precipitation, and direct runoff. Nutrients, particularly nitrogenous compounds, may contribute to increased biological productivity and dissolved oxygen deficits, thereby accelerating the natural process of eutrophication in lakes and ponds.

Forestry – Use of heavy equipment in the harvesting of forest products can disturb the soil, resulting in erosion and sedimentation of stormwater runoff. Rutting of the harvest roads, over-harvesting in wetland areas, a lack of erosion controls during installation of temporary or permanent stream crossings, over-spacing of water bars and operating equipment on slopes greater than 60% can all result in serious erosion and sedimentation of receiving waters.

Hydrologic/Habitat Alteration – Hydrologic modifications, such as changes in the flow or geomorphology of a stream, can directly alter water quality by lowering re-aeration rates and increasing water temperature, thereby exacerbating the effects of in-stream contaminants such as nutrients and oxygen demanding substances. Hydrologic modification can also change the value of aquatic habitats and result in discharge of construction-related silt and sediments.

Highway Maintenance and Runoff – Maintenance activities include road salt application, sanding and sweeping of roads, paving, bridge cleaning and painting, maintenance of sediment/erosion control basins adjacent to highways and maintenance and storage of equipment in municipal and state owned garages. Water resources can be affected by stormwater runoff contaminated with the salts, metals and paint residues, sediments, sand and cleaning agents associated with these activities.

Urban Runoff – Urbanization increases the amount of landscape rendered impervious to rainwater and snowmelt, changing watershed hydrology, and increased the potential for flooding. The changes also channelize the stormwater, increasing the velocity of runoff flow to receiving waters. Pollutants in the runoff accumulate rapidly in urban environments. Sources of urban runoff pollutants include automotive exhaust particles, oils and fluids, litter, debris, vegetative matter, and animal droppings. Pollutants transported by these widely diverse sources are sediments, nutrients, bacteria, oxygen demanding substances, oil and grease, trace metals and chemicals, and various salts.

B. Millers River Watershed Study Area

The Millers River watershed is located in north central Massachusetts and southwestern New Hampshire. It is bordered on the east by the Nashua River watershed, on the west by the Connecticut River watershed, and on the south by the Chicopee River watershed. From its tributaries of origin in New Hampshire, the Millers River flows south, then gradually west flowing into the Connecticut River. The upper tributaries originate in the Naukeag Lakes area in Ashburnham. The North Branch of the Millers River drains Lake Monomonac in Winchendon. The two branches join at Whitney Pond in Winchendon. Further south, the Otter River meets the Millers at the Lake Denison and Birch Hill Dam area, and the Tully River joins it in Athol. Both of these tributaries largely flow through wetlands.

The Millers River watershed drains an estimated three hundred and ninety-two (392) square miles, three hundred and twenty (320) of which are in Massachusetts (DEP; 1995). The total river length is fifty-one (51) miles, forty-four (44) of which are in Massachusetts. Fourteen subwatersheds drain into the mainstem of the Millers River. Two of the larger subwatersheds are the Tully River (74.0 square miles) and the Otter River (60.4 square miles). These tributaries were the subjects of field assessments for this project.

Within Massachusetts, the watershed straddles the boundary between Worcester and Franklin counties. Eighteen Massachusetts communities, mostly rural, are wholly or partially located in the watershed. Of these, eleven are located in the Montachusett Regional Planning Area in Worcester County and seven are located in Franklin County. Based on the regional boundary the study area is divided into two sub-regions. Most of the land area is in the Montachusett region, and includes the Otter River sub-basin. The Tully River sub-basin flows through the Town of Orange in Franklin County. The non-point source assessment in each region included the following communities:

- **Worcester County** – Ashburnham, Athol, Gardner, Hubbardston, Phillipston, Royalston, Templeton, Westminster, and Winchendon
- **Franklin County**– Erving, Orange, Warwick, and Wendell

Treatment methods for NPS water pollution will differ depending on whether the pollutants originated from urban or agricultural land uses. The communities of Athol, Erving, Gardner, Montague, Orange, Templeton, Warwick, and Winchendon developed as industrial bases driven by waterpower from the river and its tributaries. These towns have urban centers fronting the riverbanks. Historically, urban centers used rivers as receptacles for trash, or byproducts of manufacturing. Common byproducts included salts, heavy metals, petrochemicals, and poly-chlorinated biphenyls (PCB's)[3]. In addition, industrial withdrawals of water from nearby rivers and streams used in the manufacturing process are often returned with higher water temperatures. These elevated temperatures could potentially affect the survival of water species. Fortunately, most of these land uses have been corrected and are under strict environmental regulations. However, stormwater runoff from non-sustainable lawn care practices, automobile residues, roads and parking lots, or areas with limited vegetated buffers contribute sediment to surface waters that could lead to degradation of water quality. Moreover, during large rainstorms, sewer systems that are directly connected to storm drains could result in direct discharges of raw sewage into the water bodies.

The communities of Ashburnham, Hubbardston, Phillipston, Royalston, Wendell, and Westminster developed as agrarian land grants. Many are rich in natural resources and are popular recreation destinations. In some cases, their agrarian economies were complemented with local sawmills and woodworking shops. Non-sustainable agricultural practices can contribute sediment from soil erosion, excessive nutrients from fertilizers, poisons from pesticides, and bacteria from animal wastes.

[3] Polychlorinated Biphenyl – any of several compounds that are produced by replacing hydrogen atoms in biphenyl (a white, crystalline hydrocarbon used as a heat-transfer medium) with chlorine, have various industrial applications, and are poisonous environmental pollutants that tend to accumulate in animal tissues.

C. Natural Resource Characteristics

The Millers River watershed has an abundance of forested areas that provide extensive and significant wildlife habitat. Approximately seventy eight percent of the watershed is forested, eleven percent is open land, eight percent is wetland, and three percent contains urban areas. Rivers, wetlands, forests, meadows, and mountain ridges provide sustenance, mating grounds, and vegetated cover, supporting stable populations of deer, otter, mink, muskrat, porcupine, fisher, and fox. There is evidence that populations of beaver, eastern coyote, black bear, and several species of migratory raptors and waterfowl have returned to the region. The watershed is also home to twenty-six species on the Massachusetts list of endangered, threatened and special concern species.

The watershed has one hundred and seven (107) lakes and ponds and reservoirs, totaling three thousand, five hundred and forty (3,540) acres. One lake, Lake Monomonac in Winchendon, has five hundred ninety two (592) acres. The mainstem of the river has eight flood control dams and hydroelectric generator facilities. The North Branch has three hydroelectric facilities, and the South Branch has two, both of which are located in Winchendon. Numerous low-head dams are located along the Otter and Tully Rivers and the small tributaries throughout the watershed. From Winchendon to its confluence with the Connecticut River, the Millers River fluctuates between sluggish and rapid flow with an average drop of twenty-two feet per mile.

The watershed has high topographical relief ranging from two hundred to fifteen hundred feet above mean sea level. Overall, the Millers River lowers in elevation moderately, averaging about eighteen feet per mile from the headwaters in New Hampshire to the USGS gage station at Erving, MA, although a five-mile reach of the Millers River between South Royalston, MA and Athol, MA drops an average of about forty-three feet per mile. The Otter River descends at an average of eighteen feet per mile over eleven river miles. The East Branch of the Tully River drops an average of fifty-two feet per mile over thirteen river miles.

The Millers River drains the western part of the ancient, formerly volcanic, Bronson Hill upland[4]. A succession of glaciers over several hundred thousand years eroded the mountainous landscape, stripping loose rock from the underlying bedrock as they advanced. At the end of the Wisconsinan glacial period, the receding glacier released huge volumes of water, forming sizable glacial lakes. A network of rivers formed when the moraines, ice, and bedrock that impounded the glacial lakes eroded and drained into the Connecticut River. The river network eventually cut through sedimentary deposits to bedrock comprised of gneiss domes mantled by schist and quartzite granite to create the current valleys[5]. Glacial deposits of till dominate the geology. However, this glacial till is acidic due to the weathering of sulfidic schists. Thus, the till has little buffer reagents against the effects of acid rain.[6]

Stratified sands and gravels are mainly confined to the river and stream valleys, providing excellent recharge areas to drinking water supplies. Three Early Mesozoic principal aquifers in the watershed provide a supply of high quality drinking water for much of the region.[7] Four aquifers are known to underlie the Town of Athol. The most productive of these underlies the Tully River. Others underlie the Millers River, White Pond/South Athol Pond, and Lake Ellis. The watershed also drains into the Connecticut River Drainage system, which flows south to Long Island Sound.

The Montachusett portion of the Millers River Watershed is included in an interim soils report for Northwestern Worcester County Massachusetts, which updates an earlier soil survey published by the United States Department of Agriculture (USDA) in 1927. The report classifies the soils in the area and their suitability and limitations for agricultural, forestry, recreation, building, and sanitation. At present, only the hand drawn field maps for the soils report are available to determine specific soil characteristics. The USDA is in process of digitizing the information but the digital data will not be available for two or three years.

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[4] Skehan, James W., *Roadside Geology of Massachusetts*, Mountain Press Publishing Company, 2001, p. 281.
[5] Gneiss – A course grained metamorphic rock with parallel alignment of banded mineral grains.
Schist – A cleavable metamorphic rock with parallel layering of platy materials. Eg. mica schist.
Quartzite – A metamorphic rock composed of quartz, formed from sandstone.
[6] Skehan, James W., *Roadside Geology of Massachusetts*, Mountain Press Publishing Company, 2001, p. 281.
[7] USGS Principal Aquifers of the 48 Contiguous United States 1998, http://www.nationalatlas.gov/aquifersm.html

According to the USDA, the underlying geology of the watershed is comprised of gneiss and schist bedrock covered with deposits of glacial till. Generally, the soils belong to soil associations that are steep and extremely stony. These steep uplands are not well suited to farming, but support healthy forested expanses. The majority of the prime forestland soils occur on the hilly glacial till ridges upland from the rivers and lakes. The sand and gravel and alluvial deposits are confined to the narrow river valleys. These sandy soils require moderate efforts to control erosion.

Erosion of the surface layer reduces productivity and mixes the subsoil into the plow layer. It lowers water quality by polluting streams, ponds, and culverts with sediment. Erosion is a hazard where slope exceeds three percent (3%). Where the agricultural soils are moderately well drained, they cannot be tilled or worked until late spring or early summer and are not well suited to early season crops.

D. Community Profiles

Tool manufacturing and furniture making were dominant industries in the past, but most of these factories have since closed and the area supports light industrial and service oriented businesses. As such, the wide array of natural resources, opportunities for recreation, low cost of living, overall lack of crime and rural community character, make the Millers River Watershed an attractive place to live and continues to grow rapidly. Many families of the Boston metropolitan area find that the rural communities are prime locations to raise children, escape urban crime and hectic lifestyles and enjoy "country" life. They also find a comparatively affordable housing stock. As more people discover the region, it is growing at a pace that is unprecedented. Such overwhelming growth pressures could lead to degraded water quality and/or diminished water quantity. For example, large tracts of land are being converted into low density housing subdivisions resulting in serious drainage, erosion and water quality problems.

Gardner and Athol possess the two single largest populations, with 20,770 and 11,299 residents respectively – over one-third of the total population (91,986) of the watershed, according to the 2000 U.S. Census. The Montachusett towns are home to most of the population in the watershed, at 75%. They also represent most of the land area, at 65%.

The region is home to many towns that between 1980 and 1990 experienced some of the highest growth rates in the Commonwealth of Massachusetts. For example, the populations of Hubbardston and Phillipston both increased by fifty six percent between 1980 and 1990. Towns in the Montachusett region grew rapidly, adding a total of 9,437 new residents (84.5% of the regional population increase). By contrast, the towns in Franklin County grew moderately during that time period, due in part to the rural nature of the communities and the very hilly forested terrain in many of them.

Though the overall growth rate reached its greatest intensity during the 1980s, the region is still growing at a rate of five percent (5%). The Montachusett portion of the region still absorbed most of the population increase during the 1990s at 83%. Notably, Hubbardston is experiencing a relatively steady long-term growth trend. Its population more than doubled between 1980 (1,797) and 2000 (3,909), and grew by forty percent (40%) between 1980 and 2000.

In raw numbers, Gardner was the town that grew the most, adding 2,225 new people between 1980 and 1990 and another 645 since 1990. Hubbardston and Winchendon followed closely, each adding over two thousand new residents in the twenty-year period. Towns that grew the least were Petersham, Templeton, Athol, Erving and Warwick. The population of Athol actually decreased by 152 since 1990. One factor contributing to the slower growth may be the distance to major employment centers such as Greenfield, Fitchburg, Leominster, and points east. The populations, growth rates, and densities per mile of municipalities in the Watershed are shown in Table I-1 by planning area.

Gardner is the most densely populated at 936 residents per square mile. Athol is next, followed by Montague, Templeton, Winchendon, and Orange. These communities were historically manufacturing centers in the region. Athol was known as "Tool-town" for its tool industry, and Gardner as "Chair City" for its furniture factories. Templeton boasted paper mills while Winchendon sprouted many industries, such as furniture, woodworking and toy production, along the Millers River.

The communities of the region developed around the former industrial centers, which principally follow the Millers River watercourse. The river forms a natural pass through the Monadnock uplands to the west and the Connecticut River Valley. Gardner is the easternmost city in the watershed, located at the headwaters of the Otter River, a major tributary of the Millers River. Agricultural or rural communities developed to serve these industrial centers.

Today, agriculture is limited, and manufacturing jobs have decreased due to the closing or relocation of traditional industries. Yet manufacturing is still a strong force in the area, with establishments such as Erving Paper Mill, Starrett Tool, Tyco-Simplex-Grennel, and Aubuchon Hardware. The major industries within the watershed are mainly paper companies.

Table I-1 Populations of Municipalities included in the Millers River Watershed

	1980	1990	Change	Percent Change '80 – '90	2000	Change	Percent Change '90 – '00	Pop Density/ Sq. Mi.
Montachusett Regional Planning Commission								
Ashburnham	4,075	5,433	1,358	33%	5,546	113	2%	143
Athol	10,634	11,451	817	8%	11,299	-152	-1%	347
Gardner	17,900	20,125	2,225	12%	20,770	645	3%	936
Hubbardston	1,797	2,797	1,000	56%	3,909	1,112	40%	95
Petersham	1,024	1,131	107	10%	1,180	49	4%	22
Phillipston	953	1,485	532	56%	1,621	136	9%	67
Royalston	955	1,147	192	20%	1,254	107	9%	30
Templeton	6,070	6,438	368	6%	6,799	361	6%	212
Westminster	5,139	6,191	1,052	20%	6,907	716	12%	195
Winchendon	7,019	8,805	1,786	25%	9,611	806	9%	222
Total	**55,566**	**65,003**	**9,437**	**17%**	**68,896**	**3,893**	**6%**	**184**
Franklin Regional Council of Governments								
Erving	1,326	1,372	46	3%	1,467	95	7%	102
Montague	8,011	8,316	305	4%	8,489	173	2%	267
New Salem	688	802	114	17%	929	127	16%	16
Northfield	2,386	2,838	452	19%	2,951	113	4%	83
Orange	6,844	7,321	468	7%	7,518	206	3%	209
Warwick	603	740	137	23%	750	10	1%	20
Wendell	694	899	205	30%	986	87	10%	31
Total	**20,552**	**22,279**	**1,727**	**8%**	**23,090**	**811**	**4%**	**94**
Watershed Total	**76,118**	**87,282**	**11,164**	**15%**	**91,986**	**4,704**	**5%**	**149**

Source: US Census, 1990 and 2000

In the wake of the industrial decline, the service sector has been growing steadily in the past few decades, as have specialized professional jobs in government, trade, and communications. Many find work in the area's schools as teachers, administrators, and groundskeepers. There are two well-known preparatory high schools – Cushing Academy in Ashburnham and The Northfield-Mt. Hermon School in Northfield – in the region, that are both fine regional employers. In fact, Northfield-Mt. Hermon is one of the largest employers in Franklin County.

Generally, many people leave the watershed to find employment. For example, the Towns of Greenfield and Amherst and the city of Northampton area are within commuting distance of the western part of the Millers River Watershed. To the south, the city of Springfield has many employment opportunities and is at the outer limits of the commuting distance. Fitchburg and Leominster are nearby to the east, and Worcester and Boston are both under two hours away. Some find success by enduring the long commute for employment. Even so, the unemployment rates, notably in the larger population centers, such as Athol, Gardner, and Orange, are consistently higher than the state average. The area is fairly secluded and doesn't have enough job opportunities to fill demand, largely due to the disappearance of the old industries as times change. The high-school dropout rate in the area is higher than the state average as well, leaving many residents without adequate education, and leading to a high poverty rate.

II. Natural Resource Characteristics

An inventory of the natural resource characteristics of the Millers River Watershed in Massachusetts provides a backdrop to the potential non-point source pollution assessment. The chapter describes the subwatersheds and their natural resources to relate the potential pollution problems to the affected waterbodies. The many water features serve as habitats for a variety of wildlife, and as drinking water supplies for the human population.

Water quality is described by river reach and lake in terms of potential as drinking water sources, support for aquatic life, and edibility of fish. Past assessments have measured content of metals, organic chemicals, nutrients, suspended solids, organic enrichment, and pathogens in the waters. These measurements were identified within specific geographic limits.

A. General Descriptions of the Subwatersheds

The Millers River watershed system contains many rivers, streams, lakes, ponds and wetlands. The region has fourteen sub-basins, as delineated by the Department of Fisheries, Wildlife and Environmental Law Enforcement (DFWELE) Riverways Program.

North Branch Millers River – This subwatershed is a headwater region for the Millers River. It is located primarily in New Hampshire and partially in the northwest corner of Winchendon. In Massachusetts, the subwatershed has a total of 1,380 acres (0.7 percent of the watershed in Massachusetts). It flows from East Rindge, New Hampshire, through Lake Monomonac to its confluence with Millers River at Whitney Pond. Most of the area is forested, though the perimeter of Lake Monomonac is rimmed with residences.

Upper Millers River – Principally located in the town of Ashburnham, this portion of Millers River flows from Sunset and Lower Naukeag Lakes. Two tributaries feed Sunset Lake, Bear Meadow Brook and Bluefield Brook. South of Sunset Lake, Millers River flows west, into Winchendon and Whitney Pond. The subwatershed has a total of 18,597 acres, representing 9.3 percent of the region. Most of the area is forested, though residential uses rim the various lakes.

Otter River – Otter River meanders westward from the Town of Gardner, forming the border between Gardner and Templeton. Eventually the river enters Templeton, flowing through a wetland from the Village of Otter River, to the Village of Baldwinville. The tributary flows through Otter River State Forest and is impounded at the Army Corps of Engineers Birch Hill Dam Flood Control Project. This subwatershed has a total of 39,411 acres and represents 19.8 percent of the Millers River watershed in Massachusetts. This area has the largest population density in the Millers River watershed, along with the greatest percentage of commercial and industrial land use. The City of Gardner and the villages of Otter River and Baldwinville most likely contain the largest percentage of impervious cover.

Middle Millers River – The main stem of the Millers River flows from Whitney Pond in Winchendon through its confluence with the Otter River to the Birch Hill Dam. From there Millers River flows west through South Royalston into Athol, where it falls through hilly terrain before leveling out into a swampy area at its confluence with Tully River, west of the Athol Central Business District. The river enters the Town of Orange where it meets West Brook, and continues west to join Moss Brook and Whetstone Brook at the Erving town line. From the Tully River through Orange, Millers River is a popular canoeing location and home of the annual River Rat Race. The subwatershed encompasses an area of 39,857 acres and represents 20 percent of the region. While there are large concentrations of residential, commercial and industrial land uses along the Millers River in both Athol and Orange, the majority of the region is forested and much of the forestland is protected open space.

Tarbell Brook – The headwaters of Tarbell Brook are in the Lakes region of Rindge and Jaffrey, New Hampshire. The brook flows south from Pearly Lake, to Damon Reservoir. West of the reservoir, Tarbell Brook meets another tributary flowing from Sip Pond. The brook flows south into Massachusetts in Winchendon at its confluence with Spud Brook in the village of Harrisville. Tarbell Brook then meets the Millers River in a

swampy area south of Bullardville and west of Hydeville in Winchendon. The area south of the New Hampshire border encompasses 4,649 acres or 2.3 percent of the region. This area is predominantly forested. Most of the residential land is used for properties with greater than one half acre in size.

Scott and Priest Brooks – Scott Brook flows south from Scott Pond in Fitzwilliam, New Hampshire, entering Massachusetts in Royalston, where its name changes to Priest Brook. The brook flows along the border of Royalston and Winchendon, through the Birch Hill Wildlife Management Area to its confluence with Millers River, near Lake Dennison. In Massachusetts, the subwatershed has 6,282 acres and represents 3.1 percent of the region. This area is almost entirely forested, though there are some large lot residences.

Lawrence Brook – Lawrence Brook flows south from a large wetland area in Fitzwilliam, New Hampshire, entering Massachusetts in Royalston. The brook continues south, passing the historic town center to the east before entering a wetland area at the foot of Gale Hill. Here Lawrence Brook flows west to Tully Lake, passing through a steep section at Athol Road. This is the location of the popular Doan's Falls. From the Massachusetts boarder, south, the subwatershed encompasses 9,218 acres, or 4.6 percent of the region. This is another heavily forested area.

Tully River – The headwaters of Tully River are at the sources of the East and West Branches of Tully Brook. The East Branch begins in Richmond New Hampshire, flowing south through extensive wetlands in Massachusetts, before entering Long Pond and Tully Lake. The West Branch begins in Warwick and Royalston, flowing south from the New Hampshire border through Tully Brook and Fish Brook, which join at Temple Hill, in Orange. The total acreage of the Tully River watershed is 21,373, representing 10.7 percent of the Millers River watershed. The area is predominantly forested, with complementary wetlands, waterbodies, agricultural land and some vacant open land. Only a small percentage of the area is residential.

Lake Rohunta – Brooks and streams in northern Petersham, eastern New Salem, and southern Athol feed a series of interconnected ponds, flowing finally into the man-made Lake Rohunta, which eventually flows into Millers River in the town of Orange. This watershed is bound, on it southern edge, by the drainage divide for the Quabbin Reservoir. The total area of this subwatershed is 12,969 acres, representing 6.5 percent of the Millers Watershed. This area is largely forested with some recreational man-made lakes rimmed with residences.

West Brook – This tributary of the Millers River flows south through Orange. It forms the boundary between the Athol and Orange before flowing into the Millers west of the Athol central business district. It has a land area of 3,723 acres, representing 2 percent of the watershed. The area is mainly forested with some large lot residential land uses. This area is heavily forested, though there are some large lot residential areas.

Gales Brook – This tributary of the Millers River flows south through the eastern side of Warwick, and into the western end of Orange, where it meets the Millers River. The subwatershed has a land area of 6,459 acres and represents 3.2 percent of the Millers watershed. Most of this region is heavily forested.

Moss Brook – Moss Brook flows south through Warwick, west of Gales Brook, and into Orange at its western edge. Its confluence with the Millers River is at the border of Orange, Erving and Wendell. The total land area is 7,755 acres, or 3.9 percent of the Millers watershed. Most of this region is heavily forested.

Whetstone Brook – This tributary flows north through Wendell on its eastern side. It shares a confluence with the Millers River with Moss Brook to the north. It has 3,134 acres and represents 1.6 percent of the Millers watershed. This region is almost entirely forested.

Lower Millers River – Millers River forms the boundary between Erving and Wendell, cutting through steep terrain on either side. Several small tributaries flow into the river along this reach. Its subwatershed area encompasses 22,064 acres, or 11 percent of the Millers River watershed. This area if mostly forested and mountainous, though it is the home of the Erving Paper Mill.

B. Topography

The topography of the watershed is hilly, with uplands relief ranging from two hundred to fifteen hundred feet above sea level. The Millers River and the Otter River drop moderately, at an average of eighteen to twenty feet per mile from the Worcester Plateau Region on the eastern end of the watershed. Beyond their confluence in Templeton one can see evidence of the powerful forces at work during the glacial ages. The river and its tributaries cut through the bedrock following the path of the ancient glaciers. The East Branch Tully River drops an average of fifty-two feet per mile over thirteen river miles, before leveling out at the confluence with the Millers River in Athol. (*See USGS Topography Map)*

The Millers River drains the western part of the formerly volcanic Bronson Hill upland, the remnant of giant folds of rock created when supercontinents collided. The Bronson Hill Upland is the divide between the Laurentian continent and pieces of an early supercontinent known as Gondwana that were joined in the collision that formed the continent Pangaea. Later, the Pangaean supercontinent split apart, forming North America and Europe. A succession of glaciers since then eroded the mountainous landscape, stripping loose rock from the underlying bedrock as they advanced.

At the end of the Wisconsinan glacial period, the receding glacier released huge volumes of water. Barriers, such as moraines, ice, and bedrock, impounded the water forming large glacial lakes. The rivers formed when several glacial lakes joined and washed away the ice barriers and loose sediments. They spread layers of sand and gravel over broad areas, forming outwash plains. Eventually, they drained into the Connecticut River. Millers River and its tributaries cut through bedrock comprised of gneiss domes mantled by schist and quartzite granite. Glacial deposits of till dominate the geology. Drumlins populate the area, the result of clay-rich sediments being compacted against rock outcroppings. Stratified sands and gravels are mainly confined to river and stream valleys. The till of the basin is acidic due to the weathering of sulfidic schists. The till cannot buffer the effects of rainwater, especially acid rain, so the river is vulnerable to environmental acidification.[8]

The eastern portion of the watershed is an elevated plateau over one thousand feet high. As one travels west, the actions of the glaciers and the Millers, Otter, and Tully Rivers on the plateau become apparent, leaving looming hills. The towns of Royalston, Athol, Warwick, Erving, and Wendell are rugged, hilly areas with deep trough-like valleys. These hills are the southern end of the Monadnock range. The banks of the Millers River in Athol, Erving and Wendell are steep, exceeding 25 percent slope in many areas. *(See Slopes Map)*

The surficial geology of the watershed shows vast regions in Winchendon, Ashburnham, Gardner, Templeton, Phillipston, Athol and Orange that contain sand and gravel deposits. These regions also coincide with some of the best quality water supplies in the watershed. The Town of Athol sits on a great sand plain, the remnant of a glacial lake. These sand deposits are sought after for sand and gravel operations and generally contain groundwater aquifers. *(See Surficial Geology Map)*

[8] Skehan, James W., *Roadside Geology of Massachusetts,* Mountain Press Publishing Company, 2001, p. 281.

Map: USGS Topographic Map of the Millers River Watershed

Map: Slopes of Millers River Watershed

Map: Surficial Geology of Millers River Watershed

C. Soils

Soils form over thousands of years through natural processes of the climate, the weather cycle, and vegetative growth, as they impact the geologic components of the landscape. By observing the soils in an area and relating their position to specific segments of the landscape, soil scientists can develop models of soils formation that predict the kind of soil that can be expected at similar locations in the landscape. The modeling helps landowners, scientists, and engineers determine the suitability and management needed for agriculture, forestry, recreation, urban development, roadway construction and maintenance, and water management.

The soil information in this chapter is from general soils maps and the soils report for Franklin County and the Interim Soils Report for Northwestern Worcester County Massachusetts, which updates an earlier soil survey published by the United States Department of Agriculture (USDA) in 1927. The reports classify the soils in the area and their suitability and limitations for agricultural, forestry, recreation, building, and sanitation. At present, only the hand drawn field maps for the Northwestern Worcester County soils report are available. The United State Department of Agriculture is in process of digitizing the information but the digital data will not be available for two or three years.

Soil is an important factor in water quality in that it filters nutrients, pathogens and other contaminants from ground water and runoff from precipitation. Soils also have restrictive properties that affect drainage, irrigation, terraces and diversions, and grassed waterways. Properties such as permeability, slope, stone content, organic matter, salt content, chemical and mineral composition, water table level, and drainage capacity all impact the application of soil groups to specific uses.

Based on the underlying geology, much of the watershed upland is comprised of gneiss and schist bedrock covered with deposits of glacial till. As stated previously, the till is comprised of sulfidic schists with limited capacity to buffer the effects of acid rain.[9] Many of the soils belong to soil associations that are steep and extremely stony. These steep uplands are not well suited to farming, but support healthy forested expanses. The majority of the prime forestland soils occur on the hilly glacial till ridges upland from the rivers and lakes. The sand and gravel and alluvial deposits are confined to the narrow river valleys. These sandy soils require moderate efforts to control erosion.

Erosion of the surface layer reduces productivity and mixes the subsoil into the plow layer. It lowers water quality by polluting streams, ponds, and culverts with sediment. Erosion is a hazard where slope exceeds three percent (3%). Where the agricultural soils are moderately well drained, they cannot be tilled or worked until late spring or early summer and are not well suited to early season crops.

Montachusett Region

The eastern portion of the Millers River watershed has three main soils associations: Becket-Skerry-Monadnock, Colton-Adams-Wonsqueak, and Peru-Berkshire-Marlow. They are all nearly level to very steep soils developed in areas of glacial till. In general, the soils are not well suited to agricultural uses, but they are considered to be prime forestland soils.

The Becket-Skerry-Monadnock series consists of gently sloping to very steep, deep, well-drained soils on uplands. They formed in glacial till, ground moraine, and stratified drift. The Skerry soils tend to be gently sloping, very deep and moderately well drained, located in depressions and shallow drainage-ways of uplands. They formed in a loamy mantle overlying dense, Wisconsin age sandy, stony glacial till derived from granitic, schistose, and gneissic rocks. They are nearly level to moderately steep soils found on drumlins and glaciated uplands. The composition of the series is fine sandy loam that is moderately rapid in permeability underlain by a sandy loam hardpan at a depth of two to three feet. They tend to be extremely stony.

Colton-Adams soils are mineral soils on outwash plains that surround Wonsqueak soils. The Colton-Adams series consists of very deep, very strongly acid, excessively drained gravelly loamy sand in a forested area.

[9] Skehan, James W., *Roadside Geology of Massachusetts*, Mountain Press Publishing Company, 2001, p. 281.

They formed in glacio-fluvial deposits or glacio-lacustrine sand. They are on deltas, lake plains, moraines, terraces, kames, eskers, and outwash plains. Slope ranges from 0 to 70 percent. Runoff is very slow to medium. Permeability is rapid or very rapid in the surface layer and upper part of the subsoil and very rapid in the lower part of the subsoil and substratum.

Large areas are idle and support seedling aspen, birch and pine, bracken fern, sweet fern, spirea, brambles, and blueberries. Farmed areas are used mainly for grass hay or pasture with some corn and oats. Forests include sugar maple, beech, eastern white pine, red pine, and white spruce.

The Wonsqueak series consists of muck, in a wooded or shrubby bog, very deep, very poorly drained soils that formed in a mantle of well-decomposed organic soil material over loamy mineral material. Wonsqueak soils formed of organic material derived mainly from herbaceous materials with lesser amounts of materials from woody plants and sphagnum mosses. The underlying mineral substratum is loamy material from glacial sediments of late Wisconsin age. They are found primarily in shallow depressions in glacial ground moraine, till plains, flood plains, between shallow till ridges, outwash plains, and deltas. They are also on the shallow perimeter of deeper organic bogs. Slope is 0 to 2 percent. Permeability is moderately slow to moderately rapid in the organic material and moderate or moderately slow in the underlying mineral material. Runoff is very slow or ponded.

Woodland vegetation includes northern white cedar, red maple, tamarack, black spruce, alder, balsam poplar, quaking aspen, and balsam fir. Under-story vegetation includes sphagnum moss, leather leaf, Labrador tea, and various grasses and sedges.

The Peru-Berkshire-Marlow association are very deep, moderately well drained soils that occur on the hilly, dense, loamy glacial till ridges and drumlins upland from the watershed's rivers and lakes. The soils consist of stony, fine sandy loam, on slopes ranging from 10 to 30 percent. They developed in stony till of late Wisconsin age, derived principally from acid, gray to black or olive mica schist with some phyllite, granite and gneiss. They tend to be found in a forested area. Permeability of the soils association is moderately slow. The Marlow soils are in a drainage sequence with the moderately well drained Peru soils. They tend to be strongly acid. Potential for runoff is medium to high.

These soils are generally considered to be prime forestland soils, which are characterized as rolling, steep and extremely stony. Areas cleared of stones are used mainly for hay and pasture and some cultivated crops. Largely forested with beech; paper, black, and yellow birch; sugar and red maple; eastern hemlock, red spruce, balsam fir, eastern white pine, red pine, white ash, and basswood. Cleared areas are used for growing grasses and legumes for hay and pasture, corn for silage used in support of dairying, and potatoes. A few areas are in urban uses.

Upland Area to the East

The towns of Winchendon, Phillipston and Royalston and the northwest region of Ashburnham around Sunset Lake and Lower Naukeag Lake all have soils comprised almost entirely of Becket-Skerry-Monadnock soils. However, the perimeters of Ward Pond in Ashburnham, Whitney Pond, Millers River, and its North Branch in Winchendon, Priest Brook, Lawrence Brook, and Tully River in Royalston consist of the Colton-Adams-Wonsqueak soil association.

Otter River and Upper Millers River Subwatersheds

Soils in Templeton and western Gardner are primarily made up of the Becket-Skerry-Monadnock association. The northern tier of Hubbardston, southern Ashburnham and southern Gardner are comprised of the Peru-Marlow-Berkshire soil association: These soils are nearly level to very steep and developed in areas that average under 47 degrees Fahrenheit.

However the areas around Trout Brook in Templeton, the Whitman River and perimeter of Lovewell Pond in Westminster, and Otter River and Wright Reservoir in Gardner consist of the Colton-Adams-Wonsqueak soil association.

Athol

Athol's soils were influenced by the deposition of a large glacial lake that once straddled Athol and Orange. Over thousands of years, sediments ran off surrounding hills and collected as thick layers of sand, silt and gravel on the lake bottom. When the lake drained, the rich sediments were left behind. Today, these deposits measure approximately two hundred (200) feet thick and extend over thirteen (13) square miles.

The majority of the soils occur on hilly, glacial till ridges upland from the rivers and lakes in Athol to the north-east and to the southeast of the Millers River. The soils are comprised mainly of the Montauk-Scituate-Canton, the Ridgebury-Whitman, and the Peru-Berkshire-Marlow associations, which are characterized as rolling, steep and extremely stony. The floodplain of the Tully and Millers River to the west and the plateau surrounding Lake Ellis consist of the Hinkley-Merrimack-Freetown soil association. These soil associations are nearly level to very steep soils that developed in areas averaging over 47 degrees Fahrenheit.

Franklin County Area

Shapleigh-Essex-Gloucester is the primary soil association for the subwatersheds in the Franklin County portion of the Millers River Watershed, an area encompassing the West branch of the Tully River, West Brook, Gales Brook, Moss Brook, Lower Millers River, and Whetstone Brook. These soils range from shallow to deep. They are well-drained soils formed in stony, sandy, and gray glacial till. They contain many large boulders. The area is marked by forested, rolling, stony and rocky hills. Mount Grace, in the town of Warwick, is a prominent feature of the landscape.

Shapleigh soils are shallow, and found on steeper slopes with many rock ledges or outcrops. The Gloucester and Essex soils are found on the upper parts of the hills. The soils are difficult to farm because they are droughty, rocky and have low fertility.

At the eastern edge of the Franklin County region, and the western end of the Middle Millers River subwater-shed, where the center of Orange developed, the soils consist of the Hinckley-Merrimack association. They are droughty, sandy and gravelly soils that formed on the outwash plains and stream terraces of the former lake basin that preceded Millers River. These soils formed in deep deposits of sand and gravel. The loamy sandy soils are underlain by a layer of gravel at a depth of about two feet. Most of the soil association is used for housing or forestry.

D. Water Features

Miller River Watershed is rich in water resources. Numerous streams and rivers thread through the landscape, feeding the Millers River from the upland terrain. The region has scores of ponds and lakes, many of which serve as recreation areas, fishing sites, and public drinking water supplies (some of which are classified as outstanding resource waters. Many of the waters have abundant fish populations, and some of the waters are stocked with trout. Wetlands exist in abundance, providing needed habitat to the flora and fauna of the region. Adjacent to the rivers and streams are 133,540 acres of floodplain, that serve to absorb high waters during winter and spring snowmelt periods and during major storm events. These areas are rich in alluvium, a sought after agricultural soil type. Vernal pools abound in the region. Of these forty-four have been certified. The Water and Environmental Resources map illustrates the locations of the major waterbodies, public drinking water supply areas, and wetlands of the region.

1. Surface Waters

Millers River has eleven main tributaries that represent most of the subwatersheds in the region. In addition, the eighty smaller tributaries feed the river system as shown in Table II-1. Many of these streams and brooks connect numerous ponds and lakes, both natural and man-made. Many of the lakes and ponds in the Millers River Watershed offer a wide variety recreational activities, including motor-powered and wind-powered boating, canoeing, and kayaking, fly fishing and ice fishing in both warm and cold water fisheries, swimming, hiking, and camping. Some are for industrial purposes, and a select few meet the area's public drinking water requirements. *(See Table II-2)*

Table II-1: Streams and Rivers in the Millers River Watershed

Subwatershed	Rivers, Streams, and Brooks
1) North Branch Millers River	Millers River North Branch
2) Upper Millers River	Bearmeadow Brook, Bluefield Brook, Estees Brook
3) Otter River	Bailey Brook, Baker Brook, Beaman Brook, Crow Hill Brook, Foster Brook, Hubbardston Brook, Mahoney Brook, Norcross Hill Brook, Otter River, Perley Brook, Pond Brook, Templeton Brook, Trout Brook, Wilder Brook
4) Middle Millers River	Beaver Brook, Buckman Brook, Chickering Brook, Coolidge Brook, Dunn Brook, Fall Hill Brook, Gulf Brook, Hoyt Brook, Ice Company Brook, Kenny Brook, Lamb City Brook, Mill Brook, Millers River, North Pond Brook, Red Brook, Rich Brook, Stockwell Brook, Thousand Acre Brook, West Gulf Brook
5) Tarbell Brook	Robbins Brook, Spud Brook, Tarbell Brook
6) Scott/Priest Brook	Priest Brook, Scott Brook, Towne Brook
7) Lawrence Brook	Lawrence Brook
8) Tully River	Boyce Brook, Collar Brook, Falls Brook, Fish Brook, Tully Brook, Tully River, Tully River East branch, Tully River West Branch
9) Lake Rohunta	Cold Brook, Ellinwood Brook, McIver Brook, Nelson Brook, Riceville Brook, Thrower Brook, Willow Brook
10) West Brook	Cheney Brook, Poor Farm Brook, West Brook
11) Gales Brook	Black Brook, Gales Brook, Hodge Brook, Orcutt Brook, Rum Brook
12) Moss Brook	Darling Brook, Moss Brook, Shepardson Brook
13) Whetstone Brook	Whetstone Brook
14) Lower Millers River	Briggs Brook, Jacks Brook, Keyup Brook, Mormon Hollow Brook, Osgood Brook, Packard Brook, Wickett Brook

Sources: Department of Environmental Protection, DFWELE GIS Program, MassGIS, Arrow Map, Inc. Street Atlases for Central and Western Massachusetts, DeLorme Massachusetts Atlas & Gazeteer, Topo Maps of the Entire State.

Map – Water and Environmental Resources

Table II-2: Lakes and Ponds in the Millers River Watershed

Subwatershed/Town	Purpose	Lake or Pond
North Branch Millers River		
Winchendon	Industrial	Whites Mill Pond
Winchendon	Recreational/Fishing	Lake Monomonac
Upper Millers River		
Ashburnham	Public Water Supply	Upper Naukeag Lake
Ashburnham	Recreational	Lake Watatic, Lower Naukeag Lake, Sunset Lake, Wallace Pond
Otter River		
Gardner	Public Water Supply	Cowee Pond, Crystal Lake, Wrights Reservoir
Gardner	Recreational/Fishing	Bents Pond, Kendall Pond, Dunn Pond
Templeton	Recreational	Partridgeville Pond
Templeton	Swimming	Beamon Pond
Gardner		Hilchey Pond, Parker Pond, Ramsdall Pond
Templeton		Bourn-Hadley Pond, Brazell Pond, Depot Pond, East Templeton Pond, Greenwood Pond, Ridgeley Pond, Stonebridge Pond
Westminster		Greenwood Pond, Minott Pond South, Minott Pond
Winchendon		Mud Pond, Stoddard Pond
Middle Millers River		
Athol	Public Water Supply	Lake Ellis, Newton Reservoir, Reservoir No. 1, Thousand Acre Reservoir
Athol/Phillipston	Public Water Supply	Phillipston Reservoir, Reservoir No. 2
Orange	Recreational/Fishing	Lake Mattawa (North Pond Brook Reservoir)
Winchendon	Flood Control/Recreational/ Fishing/Swimming	Lake Denison
Winchendon	Industrial	Whitney Pond
Athol		Paige Pond, Ward Pond
Royalston		Beaver Pond
Winchendon		Stoddard Pond
Tully River		
Royalston	Recreational/Fishing	Tully Lake
Athol	Recreational	Sportsman's Pond
Athol		Silver Lake
Orange		Royalston Road Pond, Tully Pond
Royalston		Beaver Flowage Pond, Long Pond
Warwick		Sheomet Lake
Lake Rohunta		
Athol/New Salem	Recreational	Lake Rohunta
Athol		South Athol Pond, Riceville Pond, White Pond, Davenport Pond
New Salem		North Spectacle Pond, South Spectacle Pond
Gales Brook		
Warwick	Public Water Supply	Richards Reservoir
Warwick		Gales Pond, Hastings Pond, Lily Pond, Moores Pond, Wheelers Pond
Moss Brook		
Erving/Warwick		Laurel Lake
Lower Millers River		
Wendell		Bowens Pond, Ruggles Pond, Wickett Pond

Sources: Department of Environmental Protection, DFWELE GIS Program, MassGIS; Arrow Map, Inc. Street Atlases for Central and Western Massachusetts; DeLorme Massachusetts Atlas & Gazeteer, Topo Maps of the Entire State.

The Division of Fisheries and Wildlife (DWF) stocks selected waters with trout, as listed in Table II-3. Each year, the DWF stocks the Bear's Den section of the Millers River with salmon.

Table II-3: Trout Stocked Waters of Millers River Watershed

Montachusett Region	
Ashburnham	Phillips Brook, Whitman River
Athol	Ellinwood Brook, West Brook, Tully River, Millers River, Silver Lake
Gardner	Kendall Pond, Dunn Pond, Otter River
Hubbardston	Natty Pond Brook, Burnshirt River, Asnacomet Pond, Canesto Brook, Joslin Brook, Ware River (West Branch and East Branch)
Phillipston	Beaver Brook
Royalston	Lawrence Brook, Tully Brook (E. Branch), Priest Brook, Scott Brook, Millers River
Westminster	Phillips Brook, Burnt Mill Pond Brook, Wyman Pond Brook, Crow Hill Pond
Winchendon	Millers River, Tarbell Brook, Lake Dennison, Priest Brook
Franklin County	
Erving	Keyup Brook, Laurel Lake, Millers River
Montague	Goddard Brook, Sawmill River, West Pond, Millers River
New Salem	Swift River (Middle Branch)
Northfield	Four Mile Brook, Mill Brook, Roaring Brook, Pauchaug Brook
Orange	Tully Brook (W. Branch), West Brook, Moss Brook, Lake Mattawa, Orcutt Brook, Millers River
Warwick	Tully Brook, Moss Brook, Moore Pond, Mill Brook, Orcutt Brook, Sheomet Pond, Laurel Lake

http://www.state.ma.us/dfwele/dfw/dfwsttrt.htm

Millers River offers fishing opportunities for largemouth bass, brown trout, and rainbow trout (both native and stocked). The Appalachian Mountain Club Guide to Freshwater Fishing in New England describes other freshwater fishing opportunities present in the watershed, as listed in Table II-4 by subwatershed and waterbody. The main fish species available in these waters include two estuarial species: White Perch and Rainbow Smelt; five warm water species: Horned Pout, Chain Pickerel, Northern Pike, Yellow Perch, and Largemouth bass; and four cold water species: Smallmouth Bass, Brown Trout, Rainbow Trout, and Common or White Sucker.

Fishermen are cautioned not to eat trout caught in the Millers River due to the levels of mercury found in the fish. At Whitney Pond, in Winchendon, Upper Reservoir, in Westminster, Lake Rohunta (all three basins), in Athol, Orange and New Salem, people are advised not to let children, pregnant women, or nursing mothers consume any fish caught there, due to the risks associated with mercury for developing fetuses and young children. The general public is advised to limit its consumption of fish caught there. A similar caution applies to largemouth bass caught at Lake Dennison. On Gales Pond, in Warwick, the same advisory has been issued except yellow perch is the species that should not be consumed. On Upper Naukeag Lake, in Ashburnham, the same advisory has been issued except smallmouth bass and yellow perch are the species that should not be consumed. These cautions should not deter the sport fishermen from fishing. It is advised that they engage in catch and release fly-fishing.

Table II-4: Fishing Opportunities in Lakes and Ponds in the Millers River Watershed

Subwatershed	Town	Fishing Opportunities
North Branch Millers River		
Lake Monomonac	Winchendon/Rindge, N.H.	White Perch, Horned Pout, Chain Pickerel, Yellow Perch
Upper Millers River		
Lower Naukeag Lake	Ashburnham	Horned Pout, Chain Pickerel, Yellow Perch
Otter River		
Kendall Pond	Gardner	Horned Pout, Chain Pickerel, Yellow Perch
Dunn Pond	Gardner	Horned Pout, Chain Pickerel
Middle Millers River		
Lake Mattawa (North Pond Brook Reservoir)	Orange	Rainbow Smelt, Horned Pout, Chain Pickerel, Yellow Perch, Rainbow Trout
Lake Denison	Winchendon	White Perch, Rainbow Smelt, Horned Pout, Chain Pickerel, Yellow Perch
Whitney Pond	Winchendon	Chain Pickerel, Largemouth Bass
Tully River		
Tully Lake	Royalston	Horned Pout, Chain Pickerel
Sheomet Lake	Warwick	Brown Trout
Lake Rohunta		
Lake Rohunta	Athol/Orange/New Salem	Horned Pout, Chain Pickerel, Northern Pike, Yellow Perch
Gales Brook		
Moores Pond	Warwick	White Perch, Horned Pout, Chain Pickerel, Yellow Perch
Moss Brook		
Laurel Lake	Erving/Warwick	Horned Pout, Chain Pickerel, Rainbow Trout

Source: AMC Guide to Freshwater Fishing in New England, Brian R. Kologe, Appalachian Mountain Club, © 1991, First Printing 1947.

2. Wetlands

Wetlands, as defined under Section 404 of the Clean Water Act of 1972, are those areas that are inundated or saturated by ground water (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, fens and similar areas. Among many other things wetlands help to improve water quality, and regulate water levels within a watershed thus reducing flood and storm damages.

Wetlands are dynamic ecosystems and an invaluable resource to our communities. They release essential elements into the atmosphere such as nitrogen, sulfur, and carbon. Wetlands also trap sediment, and organic matter and absorb nutrients from water flowing through the hydrophytic vegetation, thus improving the quality of water for the community. That is, since most of the wetlands in the watershed are found along streams or rivers and possibly abut deeper sand and gravel deposits, they function as natural filters for surface waters and groundwater/aquifers. Wetlands provide habitat for a variety of flora and fauna including many species of special concern. Moreover, wetlands play a role in controlling flooding in a community by ponding heavy precipitation events allowing for lower runoff rates. This compensatory storage occurs in wetlands since they are generally areas with low relief or depressions formed by glacial activity or former locations of shallow lakes and ponds. The soil in wetlands, consisting of organic matter and other finer material, has limited permeability, thereby, retention of stormwater or ponding. Described further, wetlands are transitional areas between terrestrial and aquatic habitats. In fact, there are at least five different types of inland wetlands, which are categorized as swamps, marshes, bogs, fens and vernal pools in Massachusetts[10]. Due to the variety of wetlands, a classification system was developed to inventory, evaluate and manage these natural resources.[11]

[10] Tiner, R.W. 1998. In Search of Swampland. A Wetland Sourcebook And Field Guide. Rutgers University Press. NJ. 264pp.

[11] Cowardin, L.M., V. Carter, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. USFWS. Washington, D.C. FWS/OBS-79/31.

Wetlands Classification[12,13]

The US Fish and Wildlife Service developed a comprehensive classification system for wetlands in support of a new National inventory. This classification (known as the Cowardin System) is intended to ensure uniformity throughout the United States particularly for the inventory and mapping of wetlands and deepwater habitats.

The system classifies wetlands into two basic types: coastal (tidally influenced) and inland (non-tidal). The classification further defines five major systems of wetlands: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. For this report the GIS mapping focused on the major classes of wetlands found in the Millers River Watershed: Lacustrine, Riverine, and Palustrine.

Lacustrine Wetlands are characterized by (1) being situated in a topographic depression or dammed river channel; (2) lacking trees, shrubs, persistent emergents, or lichens and (3) whose total area exceeds 20 acres, or less if the boundary is active wave-formed or bedrock or if the water depth in the deepest part of the basin exceeds 6.6 ft at the low water mark.

Riverine Wetlands are all wetlands and deepwater habitats that are located within a channel except those wetlands (1) dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and (2) which have habitats with ocean derived salinities less than .5 parts per thousand. Water is generally flowing in a Riverine system. These wetlands do not include adjacent Palustrine wetlands.

Palustrine Wetlands are all non-tidal wetlands populated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Palustrine Wetlands also include wetlands lacking the aforementioned vegetation but contain all of the following characteristics: (1) total area contains less than 20 acres; (2) lacking an active wave-formed or bedrock boundary; (3) 1ater depth is less than 6.6 ft in the deepest part at the low water mark; and (4) ocean derived salinities less than .5 parts per thousand.

Commonwealth of Massachusetts Wetland Protection Act

Under Massachusetts General Laws Chapter 131 Section 40 wetlands and associated buffer zones are a protected natural resource. In 1962 the Commonwealth of Massachusetts promulgated the first coastal Wetland Protection Act (WPA) in the country. In the early 1970's, the act was amended to include inland wetlands. During 1996, the Rivers Protection Act added a new protected resource area and accompanying performance standards to the Wetlands Protection Act [14].

The WPA has several natural resource areas under protection. These include land under water bodies, banks, riverfront areas, bordering land subject to flooding, isolated land subject to flooding, certified vernal pools, coastal wetlands and bordering vegetated wetlands.[15].

In Massachusetts, wetlands are defined by vegetation, hydrology and topography. This includes all types of inland wetlands such as bogs, swamps, marshes and wet meadows. Each type of wetland is grouped into one category known as Bordering Vegetated Wetlands (BVW). That is, BVW's are wetlands that border a surface water body or other protected resource (perennial rivers and streams). BVW's are delineated based upon plant type and soil conditions.

BVW's must have at least 50% of hydrophytic vegetation and be inundated with water at least 7 to 14 days during the growing season to be considered wetlands under the MA WPA. Different species of hydrophytic vegetation (i.e., plants that tolerate "wet conditions") serve as indicator plants commonly found in wetlands. To

[12] North Carolina State University Wetlands website http://h2osparc.wq.ncsu.edu/info/wetlands/index.html.
[13] Northern Prairie Wildlife Research Center, http://www.npwrc.usgs.gov/resource/1998/classwet/intro.htm
[14] Protecting Wetlands in Massachusetts, http://state.ma.us/dep/consumer/protwet.htm
[15] Protecting Wetlands in Massachusetts, http://state.ma.us/dep/consumer/protwet.htm

identify and sort between hydrophytic and hydrophobic plant species hundreds of plants were categorized into a National List[16].

Several federal agencies developed a National List of Plant Species that occur in wetlands. This list identifies plants commonly found in drier soil conditions or uplands and plants found in wetter soil conditions. The plants are listed according to both the common name and scientific name (Genus and species) of each plant. The federal agencies emphasized that scientific names should be used when referring to a particular species due to the potential confusion with several common names that exist for one plant species. For example, Green Ash is also commonly referred to as Cottonwood, which can also include red ash or white ash. The white ash is more commonly found in upland areas whereas green ash can tolerate a wetter root structure for longer periods of time. That is green ash is known as *Fraxinus pennsylvanica*, where as *Fraxinus americana* is white ash. Therefore, the scientific name readily distinguishes these two species, which can be helpful when delineating a wetland. To further distinguish plant species indicator categories were assigned to each plant in the National List.[17]

The federal agencies assigned each of the plants to a category based upon its tolerance to frequent inundation of water. These categories are obligate (OBL), facultative wetland (FACW), facultative (FAC), facultative upland (FACU) and upland (UPL). Describe further, obligate plants have a frequency of occurring in wetlands >99% of the time; facultative wetland plants typically occur in wetlands at 67-99% of the time; facultative listed plants occur in wetlands at least 34 to 66% of the time, facultative upland plants are seldom to occur in wetlands, and upland plants rarely occur in wetlands or 99% of the time are not found in wetland areas. Pursuant to the MA Wetland Regulations 310 CMR 10.55 all plants listed as OBL, FACW and FAC are considered wetland indictor plants. Hence, a plant community with 50% or more and "listed as OBL, FACW and FAC" is a BVW in MA and is a protected natural resource.

Millers River Watershed

The Millers River Watershed contains approximately 24,122.9 acres of wetlands. The most prevalent class is the Palustrine Wetlands, which encompass an estimated 81.9% (19,762 acres) of the total wetland area. The next most abundant class is the Lacustrine Wetlands, which contains approximately 15.9% (3836.4 acres), followed by Riverine Wetlands, which encompass an estimated 2.2% (524.5 acres). The acreage of different classes of wetlands within each subwatershed is presented in Table II-5.

Table II-5: Acreage of Wetland Classes by Subwatershed

Subwatershed	Acres			
	Lacustrine	Palustrine	Riverine	Total
Gales Brook	86.4	333.3	N/A	419.6
Lake Rohunta	540.5	1,307.8	N/A	1,848.3
Lawrence Brook	N/A	1,199.7	N/A	1,199.7
Lower Millers	38.8	821.2	208.7	1,068.7
Middle Millers	535.9	3,816.1	306.3	4,658.3
Moss Brook	72.6	489.2	0.00	561.9
North Branch Millers River	188.7	13.4	N/A	202.1
Otter River	677.0	5,671.4	N/A	6,348.4
Scott/Priest Brook	N/A	876.8	N/A	876.8
Tarbell Brook	0.5	496.3	N/A	496.8
Tully River	554.3	1,555.6	7.9	2,117.8
Upper Millers River	1,076.2	2,648.8	1.5	3,726.5
West Brook	65.4	396.0	0.03	461.5
Whetstone Brook	N/A	136.6	N/A	136.6
Watershed Totals	**3,836.4**	**19,762.0**	**524.5**	**24,122.9**

Source: MassGIS National Wetlands Inventory Data Layer[18]

[16] Jackson, S. 1995. Delineating Bordering Vegetated Wetlands, Under the MAWPA

[17] Jackson, S. 1995. Delineating Bordering Vegetated Wetlands, Under the MAWPA

[18] The data obtained and generated by this data layer is generalized in nature and is intended for general planning purposes only.

The percentage of wetlands in this region that have a close proximity to developed lands is large and it is vital that we ensure the health and stability of these resources for future generations. The Millers River Watershed contains a total of approximately 3,836.4 acres of Lacustrine Wetlands. An estimated 91.6% (3,512.4 acres) of all Lacustrine Wetlands in this area are situated within 250 feet of developed land, and approximately 89.6% (3,436 acres) lie within 100ft of developed land. Table II-6 shows the breakdown of the three major classes of wetlands that dominate the Millers River Watershed.

Table II-6: Wetland Classes Within 100 & 250 feet of Developed Lands

Wetland Classification	Total Acres	Acres Within 100ft	% Within 100ft	Acres Within 250ft	% Within 250ft
Lacustrine	3,836.4	3,436.2	89.6%	3,512.4	91.6%
Palustrine	19,762.0	9,385.1	47.5%	11,615.2	58.8%
Riverine	524.5	512.4	97.7%	516.1	98.4%
Totals	**24,122.9**	**13,333.7**	**55.27%**	**15,643.7**	**64.9%**

Source: MassGIS National Wetlands Inventory Data Layer

The Millers River Watershed contains a total of approximately 19,762 acres of Palustrine Wetlands. Approximately 58.8% (11,615.2 acres) of all Palustrine Wetlands are situated within 250 ft of developed land, and an estimated 47.5% (9,385.1 acres) lie within 100 ft of developed land. The Millers River Watershed contains a total of approximately 524.5 acres of Riverine Wetlands. Approximately 98.4% (516.1 acres) of all Riverine Wetlands are situated within 250 ft of developed land, and an estimated 97.7% (512.4 acres) lie within 100 ft of developed land.

The most notable example of a Lacustrine Wetland located within 100 ft of developed land occurs to the southeast of the intersection of Lake Road and Harris Road in Ashburnham. In this location, there is a 308-acre wetland system that directly abuts a residential development. The most noticeable example of a Palustrine Wetland located within 100 ft of developed land occurs to the east of the intersection of Old Turnpike Road and Delano Road in Royalston near the Winchendon border. In this location there is a 183-acre wetland system that directly abuts a residential development. The most noticeable example of a Riverine Wetland located within 100 feet of developed land occurs along the Millers River stretching from the Montague/Erving border all the way into Orange. This wetland system encompasses 260.2 acres and directly abuts several residential, commercial, industrial and recreational developments.

3. Floodplain

Historically floodplains have been desirable places for development to occur. As early industrialists sought fast flowing water to power their mills, they created communities that served in the mills and factories. Since the floodplains typically have low slopes, and are located near the water-powered factories, people and businesses found these areas desirable to build on. However the attributes that made these areas attractive also put people and property at risk. Flooding in developed areas has caused significant property damage and in some cases even loss of life. Development within the floodplain not only places property in the path of floodwaters; it also reduces the absorption of waters into the ground, as more of the surface is rendered impervious. As a result, floodwaters tend to rise higher, causing more extensive damage.

Developed lands are not the only concern when discussing potential damages from flooding. A vast variety of flora and fauna are also at risk to danger from flooding in this region, including potentially rare and endangered species habitats. Examples of just some of the flora found in this region are pine, oak, maple, ash, beech, and hemlock forest stands. Examples of fauna that can be found in this area are deer, pheasant, osprey, river otters, red tailed hawks, the great horned owl, great blue heron, as well as many others.

A floodplain is considered to be the lowlands adjacent to a stream, river, or lake, which are susceptible to flooding. There are two main components of a floodplain, the floodway and the flood fringe. The floodway is the area adjacent to the water body that is subject to frequent flooding. It serves as a channel for diverting floodwaters. The flood fringe is the area to the outer edge of the floodplain that is subject to flooding less often, and at more shallow depths. A floodplain serves two primary functions: (1) to channel floodwaters downstream, and (2) to impede the flow of floodwater throughout the area.

Floodplain Classification

Floodplains are determined by the frequency of a flood that is large enough to cover a specific area. As an example, a 100 year floodplain has a chance of being flooded every 100 years, or a statistical probability to flood at 1% per year. Another example is that of a 500-year floodplain. A 500 year floodplain has a chance of being flooded every 500 years, or a statistical probability of 0.2% per year. Flood frequencies are calculated by plotting a graph of the occurrence and size of all known floods for a specific area and thus determining how often floods of a particular size will occur.[19]

Millers River Watershed (MRPC Region)

The MRPC Region of the Millers River Watershed contains approximately 18,364 acres of floodplains.[20] Floodplains make up an estimated 13.7% of the total acreage of the watershed in this region. Table II-7 lists the total floodplain acreage for this region. Areas inside the 100-year floodplain contain approximately 15,386.9 acres (11.5% of the total floodplain area), and areas inside the 500-year floodplain contain an estimated 2,978 acres (2.2% of the total floodplain area).

Table II-7: Floodplain Acreage by Zone

Floodplain Zone	Acres	Percent of Area
Outside 100 & 500 Year Floodplain	115,175.7	86.2%
Inside 100 Year Floodplain	15,386.9	11.5%
Inside 500 Year Floodplain	2,978.0	2.2%
Totals	133,540.6	100.0%

Source: MassGIS FEMA Q3 Flood Layer[21]

Although the acreage of floodplains within developed lands for the MRPC Region of the Millers River Watershed is small, damage from flooding in these areas can be great. Approximately 3.7% (563 acres) of the 100-year floodplain and an estimated 6.9% (205.2 acres) of the 500-year floodplain are developed. Table II-8 lists the total acreage of floodplain lands that are developed.

[19] Floodplain Management Association website http://floodplain.org.
[20] As of this writing the MassGIS FEMA Q3 Flood Layer was unavailable for the Franklin County communities.
[21] The data obtained and generated by this data layer is generalized in nature and is intended for general planning purposes only.

Table II-8: Floodplain Zones Within Developed Lands

Floodplain Zone	Acres	Developed Floodplain Acres	Percent Developed
Inside 100 Year Floodplain	15,386.9	563.0	3.7%
Inside 500 Year Floodplain	2,978.0	205.2	6.9%

Source: MassGIS FEMA Q3 Flood Layer

To protect these areas, the Army Corps of Engineers built two large flood control dams: the Birch Hill Dam, and the Tully Lake Dam. The Birch Hill Dam is located on the Millers River in the southern section of Royalston, MA. This dam was completed in 1941 by the Army Corps of Engineers and has a storage capacity of 16.3 billion gallons of water. The Tully Lake Dam is also located in Royalston, MA on the East Branch of the Tully River. The dam was completed in 1949 by the Army Corps of Engineers and has a storage capacity of 6.69 billion gallons of water. Both of these dams are part of an extensive network of flood control dams on the tributaries of the Connecticut River. The Reservoir Regulation Team (RRT) is the command center for New England flood control dams such as the Birch Hill and Tully River Dams. The RTT constantly monitors river levels and weather conditions influencing flood control decisions using radio and satellite communications.[22]

In April 1987, two storms released over six inches of rain in the region. The storm events utilized approximately 80% of the storage capacity of the Birch Hill Dam, and approximately 62% of the capacity of the Tully Lake Dam. It is estimated that the Birch Hill Dam prevented over $9 million in property damage, and that the Tully River Dam prevented over $3 million in property damage during these storms.

Although these control systems are useful in protecting people and property from flood damage they can be costly in nature to construct and maintain. Another way to protect against flooding in the future is through non-structural measures such as proper zoning and land use management including open space acquisition and conservation restrictions. Both the State and Federal Governments possess extensive land holdings that are intended to manage flood damage in the Millers River Watershed in connection with the dams. Secondarily, they serve as extensive recreational areas and wildlife habitats, adding another dimension to their value.

Furthermore, other natural resources, such as wetlands, help to mitigate flood conditions. The presence of wetlands within floodplains helps to absorb floodwaters as they flow across their paths. Approximately 67% (12,300.8 acres) of the total floodplain area for the MRPC Region of the Millers River Watershed contains wetlands. Table II-9 displays the acreage and percentage of wetlands that lie within floodplains.

Table II-9: Presence of Wetlands Within Floodplain Area

Type Of Area	**Acres**	**Percent Of Area**
Wetlands Within Floodplain Area	12,300.8	67%
Total Floodplain Area	18,364.9	100%

Source: MassGIS FEMA Q3 Flood and National Wetlands Inventory

[22] Army Corps of Engineers New England District Website http://www.nae.usace.army.mil/

4. Vernal Pools

A vernal pool is a seasonal wetland contained in a depression that lacks a permanent above ground outlet. It appears when the water table rises in the fall and winter, when the snow melts in the late winter and early spring and, and with runoff from rain. The water lasts for a few months in the spring and early summer.[23] By late summer, a vernal pool is generally dry or is otherwise free of fish. The periodic drying does not support breeding populations of fish, but many organisms have evolved that must use a vernal pool for various parts of their life cycle. Species such as the mole salamander, the wood frog, and the fairy shrimp have come to be known as indicators of the existence of vernal pools.

Vernal pools range in size from very small to very large, yet they are generally shallow (about three to four feet deep. Pools might be found in low areas of a forest, in the floodplain or a river or stream, within a vegetated wetland, in an open field, between coastal dunes, in abandoned quarries or natural rock formations and other areas where water might pool.

Millers River Watershed has forty-four NHESP Certified vernal pools. The vast majority of these pools are located in the Otter River subwatershed, primarily in the town of Hubbardston. The Town of Athol has six certified vernal pools, five of which are located in the Lake Rohunta subwatershed. The Town of Gardner has three, Wendell has two, and Winchendon has one. (*See Table II-10*). NHESP has mapped the existing Certified vernal pools and made the information available through MassGIS. These pools are depicted on the Water Features and Environmental Resources Map.

Table II-10: Certified Vernal Pools by Subwatershed and Town

Subwatershed	Town	Certification Number of Vernal Pool	
Lake Rohunta	Athol	OCVP000000*345*MA	OCVP000000*391*MA
		OCVP000002*444*MA	OCVP000002*445*MA
		OCVP000002*446*MA	
Lower Millers River	Wendell	OCVP000000*079*MA	
Middle Millers River	Athol	OCVP000000*392*MA	
Otter River	Gardner	OCVP000000*920*MA	OCVP000001*793*MA
		OCVP000001*794*MA	
	Hubbardston	OCVP000000*413*MA	OCVP000000*419*MA
		OCVP000000*423*MA	OCVP000000*424*MA
		OCVP000000*425*MA	OCVP000000*426*MA
		OCVP000000*430*MA	OCVP000000*435*MA
		OCVP000000*436*MA	OCVP000000*437*MA
		OCVP000000*441*MA	OCVP000000*442*MA
		OCVP000000*683*MA	OCVP000000*684*MA
		OCVP000000*685*MA	OCVP000000*777*MA
		OCVP000000*778*MA	OCVP000000*779*MA
		OCVP000000*790*MA	OCVP000000*794*MA
		OCVP000000*795*MA	OCVP000000*796*MA
		OCVP000000*797*MA	OCVP000000*801*MA
		OCVP000000*813*MA	OCVP000000*872*MA
		OCVP000000*874*MA	OCVP000000*875*MA
		OCVP000001*096*MA	OCVP000001*097*MA
		OCVP000001*098*MA	
Upper Millers River	Winchendon	OCVP000001*301*MA	OCVP000001*379*MA
Whetstone Brook	Wendell	OCVP000000*037*MA	

Source: National Heritage and Endangered Species Program and MassGIS.

[23] The Vernal Pool Association of Reading Memorial High School, Reading, Massachusetts.

In addition to the certified pools, NHESP has also mapped the existence of potential vernal pools throughout the state. These pools may be located in areas that represent a high priority for protection in that they may contain an abundance of species listed on the Endangered Species list. Millers River Watershed has at least 654 potential vernal pools. It may make sense to prioritize these areas for Nonpoint source protection measures, and to pursue a course of certification to obtain further protection under the wetlands protection act. In many cases this may prove to be a private decision for private landowners, however. Table II-11 provides a count of potential vernal pools by subwatershed and town.

Citizens of Massachusetts can certify the existence of a vernal pool by submitting documentation material to the Natural Heritage & Endangered Species Program. Certification qualifies the vernal pool to receive protection under the Wetlands Protection Act. Vernal pool certification requires evidence that a vernal pool exists physically and that it contains the biological indicators that define it as a vernal pool. Certification documentation can include evidence of species that also live in wetlands. If they are using a vernal pool, free of fish, then the pool can be certified. In a similar manner, if a pool is found in the dry condition (fish-free) and it has remains of these species, the dry pool can be certified. (*See Appendix A for a listing of the NHESP certification criteria*.)

Wood frogs and mole salamanders live in upland forests, but migrate to ancestral vernal pools to lay their eggs in vernal pools in early spring. The eggs hatch in the pool, and, in the case of the frogs, the tadpoles develop in the pool and eventually follow the adults to adjacent uplands. The tiny fairy shrimp spend their brief lives in vernal pools. Eggs hatch in early spring. Females eventually drop an egg case which remains on the pool bottom after the pool dries. The eggs pass through a cycle of drying and freezing, and then hatch another year when water returns. Evidence of breeding by mole salamanders (breeding congress, spermatophores, egg masses or larvae) and by wood frogs (chorusing or mating adults, egg masses or tadpoles), and evidence of all aspects of fairy shrimp life cycle indicates the presence of a vernal pool.

Table II-11: Potential Vernal Pools by Subwatershed and Town

Subwatershed	TOWN	Total	Subwatershed	Town	Total
West Brook	Athol	4	Moss Brook	Erving	1
	Orange	7		Warwick	16
Gales Brook	Orange	1	North Branch Millers River	Ashburnham	2
	Warwick	17		Winchendon	3
Lake Rohunta	Athol	16	Otter River	Gardner	34
	New Salem	10		Hubbardston	11
	Orange	7		Templeton	51
	Petersham	12		Westminster	5
	Royalston	4		Winchendon	33
Lawrence Brook	Athol	1	Scott/Priest Brook	Royalston	20
	Royalston	38		Winchendon	13
Lower Millers River	Erving	18	Tarbell Brook	Winchendon	9
	Montague	8	Tully River	Athol	14
	Northfield	7		Orange	16
	Wendell	25		Royalston	32
Middle Millers River	Athol	30		Warwick	13
	Orange	28	Upper Millers River	Ashburnham	50
	Phillipston	18		Winchendon	10
	Royalston	7	West Brook	Orange	5
	Templeton	5	Whetstone Brook	Orange	2
	Warwick	3			
	Winchendon	48			

Source: MassGIS Potential Vernal pools datalayer.

5. Outstanding Resource Waters

According to 314 CMR 4.00: "Certain waters shall be designated for protection under this provision in 314 CMR 4.06(3) including Public Water Supplies (314 CMR 4.06(1)(d) 1). These waters have outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these waters shall be protected and maintained." The Millers River Watershed contains five waterbodies that have received classification as Outstanding Resource Waters under the Massachusetts Surface Water Quality Standards of 1995[24]. All of them are public water supplies located within the Otter River Subwatershed as listed in Table II-12.

TableII-12: Outstanding Resource Waters

Waterbody	Acres
Perley Brooke Reservoir, Gardner	1,018.81
Thousand Acre Swamp, Phillipston	581.09
Crystal Lake, Gardner	632.11
Reservoir Number 2, Athol	564.58
Phillipston Reservoir	271.54

Source: MassGIS

[24] Based on information from MassGIS delineating drainage subbasins, Areas of Critical Environmental Concern (ACECs), USGS 1:25,000 quads, community boundaries, and 1:25,000 hydrography. The map work was quality checked by MA DEP Wetlands Conservancy Program staff.

E. Vegetation, Wildlife and Endangered Species

Millers River Watershed supports a wide variety of coniferous and deciduous forests, grasslands, wetlands, and riparian vegetation. The watershed has vast expanses of permanently protected vegetated open space located within the North Central Hardwoods-Hemlock-White Pine zone. Eighteen commercial species, representing a mixture of northern hardwood, upland central hardwood and white pine forests, have been observed in the Bearsden Conservation Area in Athol. Common species include white pine, red oak, red maple, black birch, white birch, white ash, sugar maple, yellow birch, beech, hickory, black cherry, white oak, aspen gray birch, cedar, hop hornbeam, and pitch pine.

A 1997 natural resource inventory of the Millers River from Orange Center to Athol Center revealed a number of unusual plant communities.[25]

- One small patch of silver maple dominated floodplain forest occurs north of the Athol town well, by South Athol Road.
- The ten-acre Cook's Cove backwater, northwest of Daniel Shay's Highway, between Lake Rohunta and the Millers River, supports aquatic vegetation such as native milfoil and emergent marsh communities. Yet, exotic invasive plants threaten to choke the diversity in the Cove.
- Adjacent to Cook's Cove, a five-acre stand of black ash occurs within a red maple swamp.
- A black cherry stand grows just north of the sewage treatment plant
- A wet meadow community thrives in an old oxbow meandering, between the Athol town-well and the sewage treatment plant.

The watershed has a diversity of major habitat types. Its rivers, wetlands, forests, meadows, and mountain ridges provide sustenance, mating grounds, and vegetated cover to the wildlife dwelling within. Since many species rely on a variety of habitat types during different periods of their life cycle, species diversity is greatest in areas where several habitat types occur in close proximity to one another. When habitats are of high quality and ample quantity, wildlife populations thrive. Selected areas are of great importance to the survival of rare and endangered species. These areas are shown on the Water and Environmental Resources map as NHESP Priority Sites and estimated Habitats of Rare Species.

Several wildlife management areas located in Winchendon, Royalston, Athol, and Phillipston support deer, otter, mink, muskrat, porcupine, fisher, fox, eastern coyote, and black bear. The return of beaver to the region has led to the creation of wetlands that provide excellent habitat for many species of transient and migratory bird life.

The Millers River is an important flyway, providing a safe foraging and resting area for large numbers of migrating waterfowl, shore birds, passerines, and raptors including Red-shouldered and Broad-Winged Hawks, Ospreys, Great-Horned and Barred owls, and Bald Eagles. Other migrants include Canada Geese, several species of ducks, and Cormorants. Great Blue Heron have been observed along stretches of the Millers River and in the beaver pond complex near Thousand Acre Swamp. Other bird species observed soaring overhead include Upland Sandpiper, Virginia Rail, Northern Shrike, Goshawk, Northern Raven, Carolina Wren, Marsh Wren, and Common Redpoll.

The Massachusetts Division of Fisheries and Wildlife (DFW) sponsors programs aimed at subsidizing local wildlife populations. One successful program involves the reintroduction of the wild turkey, which was eradicated from Massachusetts more than one hundred and fifty (150) years ago. Wild turkeys have been captured in other states and released in Massachusetts during a campaign that began forty years ago. Now the wild turkey population is soaring, with the help of strict hunting regulations and reforestation.

Local surface waters support a diversity of fish species that are popular among anglers. Several ponds and lakes offer warm water anglers the opportunity to catch large-mouth bass, pickerel, bullhead (horned pout), and pan-

[25] Matthew Hickler and the Nature Conservancy, *Millers River Greenway Natural Resource Inventory, 1997*

fish. While native populations of trout can be found in Thousand Acre Brook, Buckman Brook and Thrower Brook, the DFW stocks Ellinwood, Riceville, Tully and West Brooks with various types of native and non-native trout. Through an Atlantic salmon reintroduction program initiated by the Division in 1983, smolts have been liberated throughout the length of the Millers River below the Birch Hill Dam. Unfortunately, PCB and thermal pollution in the Millers River and dams along the Connecticut River have limited the success of this program, but the recent construction of fishways at key points has negated some of the harmful effects of the dams.

Unfortunately, the contamination of the Millers and Otter Rivers, and the East Branch of the Tully River with PCB's, mercury, metals, and pathogens lessens the overall quality of the Millers River watershed for the wildlife that depend on these corridors and habitats for migration routes and home ranges. Toxins found in the water of certain segments of the rivers affect growth in fathead minnows and leave other native fish populations off-limits to human consumption throughout the entire watershed[26].

Rare Wildlife and Endangered Species

The watershed region is home to wildlife species that are endangered, threatened or of special concern, based on several inventories done in support of conservation efforts in the watershed[27]. Several of the species sighted in the watershed are on the list of Rare, Endangered and Threatened Species, published by the Massachusetts Natural Heritage and Endangered Species Program of the Division of Fisheries and Wildlife and the Department of Environmental Management Forest Stewardship Program.

The list classifies species based on the level of concern for their survival. "Endangered" (E) species are native species in danger of extinction throughout all or part of their range, or in danger of extirpation from Massachusetts, as documented by biological research and inventory. "Threatened" (T) species are native species that are likely to become endangered in the foreseeable future, or that are declining or rare as determined by biological research and inventory. "Special concern" (SC) species are native species which have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts. Table II-13 lists the species identified in the watershed and the rank of concern. Permanently protecting the habitats of these species should be considered a top priority. Habitats that are already protected can be seen on the Water and Environmental Resources map.

Amphibians (Salamanders)
Several rare salamanders and one toad inhabit the wetlands of the watershed: the four-toed salamander, the Jefferson Salamander, the Spring Salamander, and the Eastern Spadefoot Toad. Threats to their habitat include urbanization and development, road construction, and timber harvesting. Intensive development pressure throughout this salamander's range has caused disruption of many natural coldwater springs. The loss of woodlands surrounding these springs has allowed water temperatures to rise, making the springs unsuitable for these salamanders. Pollution, degradation, and siltation of streams have also contributed to the decline in the spring salamander population. Effort should be made to identify and protect the preferred breeding habitat in bog areas and the adjacent wooded uplands. Protection measures aimed at the turtle populations should afford some protection for the salamander as well.

[26] Commonwealth of Massachusetts, Department of Public Health, *Freshwater Fish Consumption Advisory List, 2001*.
[27] Millers River Greenway, Thousand Acre Swamp

Table II-13: Endangered Species in the Millers River Watershed

Rank	Common Name	Scientific Name	Town
Amphibian			
SC	Four-Toed Salamander	Hemidactylium Scutatum	Orange, Warwick, Wendell
	Jefferson Salamander	Ambystoma Jeffersonianum	Warwick
	Spring Salamander	Gyrinophilus Porphyriticus	Royalston, Wendell, Westminster, Winchendon
T	Spadefoot Toad	Scaphiopus holbrookii	Athol
Beetle			
SC	Elderberry Long-Horned Beetle	Desmocerus Palliatus	Phillipston, Winchendon
Bird			
E	American Bittern	Botaurus Lentiginosus	Ashburnham, Gardner, Phillipston, Royalston, Westminster
	Golden-Winged Warbler	Vermivora Chrysoptera	Erving
	Least Bittern	Ixobrychus Exilis	Phillipston
	Sedge Wren	Cistothorus platensis	Athol
SC	Common Loon	Gavia Immer	Ashburnham, Gardner, Hubbardston
	Long-Eared Owl	Asio Otus	Templeton
	Sharp-Shinned Hawk	Accipiter Striatus	Ashburnham, Gardner, Westminster
T	Grasshopper Sparrow	Ammodramus Savannarum	Orange
	Vesper Sparrow	Pooecetes Gramineus	Orange, Templeton
Fish			
SC	Bridle Shiner	Notropis Bifrenatus	Athol
Mussel			
SC	Squawfoot	Strophitus Undulatus	Athol, Orange, Royalston, Warwick, Westminster
	Triangle Floater	Alasmidonta Undulata	Athol, Erving, Orange, Royalston, Templeton, Wendell, Winchendon
Odonate (Dragonflies, Darners, Damselflies)			
SC	Beaverpond Clubtail	Gomphus Borealis	Hubbardston
	Brook Snaketail	Ophiogomphus Aspersus	Athol
	New England Bluet	Enallagma Laterale	Ashburnham
	Ski-Tailed Emerald	Somatochlora Elongata	Ashburnham
E	Spring Blue Darner	Aeshna Mutata	Athol
Reptile			
SC	Eastern Box Turtle	Terrapene Carolina	Erving, Hubbardston
	Spotted Turtle	Clemmys Guttata	Athol, Hubbardston, Orange, Warwick, Wendell, Westminster
	Wood Turtle	Clemmys Insculpta	Ashburnham, Athol, Gardner, Hubbardston, Phillipston, Royalston, Templeton, Warwick, Westminster, Winchendon
Vascular Plant			
E	Sand Violet	Viola Adunca	Ashburnham
SC	Dwarf Mistletoe	Arceuthobium Pusillum	Ashburnham, Gardner
T	Bartram's Shadbush	Amelanchier Bartramiana	Ashburnham, Winchendon
	Pod-Grass	Scheuchzeria Palustris	Templeton

Sources: MA NHESP, List of Endangered, Threatened and Special Concern Species. http://www.state.ma.us/dfwele/dfw/nhesp/nhdat.htm, and *Millers River Greenway Natural Resource Inventory*, Matthew Hinkler and David Small, Biology Department, University of Massachusetts, Amherst 1997.

The Four-Toed Salamander is the smallest one found in the state. It has only four toes on the hind feet, a constriction at the base of its tail, and a bright white belly speckled with black. It breeds in the hummocks of grasses, sedges, or wet mosses found in wetlands near slow-moving streams or pools of standing water. Bogs, Red Maple and American White Cedar swamps, and vernal pools are its preferred habitats. They eat ticks, spiders, springtails, midges, ground beetles, rove beetles, fly larvae, parasitic wasps, ants, earthworms, and snails.

The Jefferson Salamander a member of the mole salamander family, looks similar to the spotted salamander. It has a slender dark body, wide nose, long toes and small silver-blue specks on its sides. It has well developed lungs. These salamanders are burrowers, spending most of their lives underground, yet they breed in water.

The Spring Salamander is one of the larger salamanders, with a stout body and a broad nose that ends abruptly. Its back and tail are light brownish-orange or salmon-red with small dark spots or flecks. A light line, bordered below by a dark line, begins at the eye and extends to the nostril. The belly is flesh-colored and the throat may be flecked with black. They inhabit in cool well-shaded mountain springs at high elevations, and wet depressions beneath logs, stones, or leaves in surrounding forests.

The Eastern Spadefoot Toad is a two-inch, plump, toad that has smooth skin with scattered warts, bright golden eyes with vertical pupils, and two wavy, yellow lines that run down the back. They eat ground-dwelling insects; especially ants and termites; spiders, and other small arthropods, and some moths. These nocturnal toads burrow underground, usually in well-drained, sandy soil along the coast, in river valleys, or in meadows, and generally appear only during the breeding season. After heavy rains in early May through late August the toads emerge from their underground burrows and commence breeding in temporary rain pools. The females lay up to 2,500 eggs each, in irregular strings along grass stems in the water. Small bronze-colored tadpoles with short, rounded, spotted tails hatch in 2 to 4 days. Their undersides are translucent. They transform 14-60 days after hatching.

Beetles

One rare beetle has been sighted in Phillipston and Winchendon. The Elderberry Long-Horned Beetle is a one-inch long dark metallic blue beetle with a bright orange and black wing. It is most often sighted in June and July. Larva feed on the roots of the elderberry, which grows on low ground in wet areas, moist forests and stream edges, and the borders of fields and copses. The adults feed on the pollen and the leaves. They lay their eggs on the elderberry stems and the larva burrow into the stems, progress to the roots and pupate in the soil. The species was once wide spread but only a few towns have reported observations of it in the last two decades. The causes of its disappearance are unknown. It was placed on the endangered species list in 1980. Recovery options include planting elderberry in appropriate habitats, to attract the beetle.

Birds

Several rare birds make their homes in the habitats of the watershed: the American Bittern, the Golden-Winged Warbler, the Least Bittern, the Common Loon, the Long-Eared Owl, the Sharp-Shinned Hawk, the Grasshopper Sparrow, and the Vesper Sparrow.

The American Bittern is a medium-sized brown heron that thrives in wetland habitats containing cattails, bulrushes, sedges and grasses. They are likely to be found in marshes, and wetland borders along lakes, ponds, rivers, and streams. The bird stands up to 34 inches tall and has a 50-inch wingspan and streaked brown plumage. When the secretive American bittern feels threatened it stands upright and freezes with its bill pointing upward, swaying from side to side, like the tall reeds and grasses surrounding it. They nest on the ground in dense grassy uplands, near water. They eat small reptiles, amphibians, mice and grasshoppers. The American bittern is considered threatened because of disturbance and the continuing disappearance of the wetland habitats it needs to exist.

The Golden-Winged Warbler has gray and white plumage, a black throat, and a yellow forehead and wing patch. It makes its home in the woodland edges of fields, pastures and power lines in early succession, nesting on the ground. The population is declining precipitously in the northeastern U.S. due to a loss of shrubland habitat from reforestation of farmlands, increasing urbanization, deforestation of tropical wintering habitat, heavy nest parasitism by Brown-headed Cowbirds, and range expansion of the Blue-winged Warbler into the range of the Golden-winged Warbler. Increased competition and widespread interbreeding between the

Golden-winged and Blue-winged warblers is highly correlated with the decline of Golden-winged warbler populations.

The Least Bittern is a tiny heron with a black back and buff wing patches. Like the American Bittern, it makes its home in freshwater marshes with cattails and reeds. It is also a secretive bird, preferring to hide and blend with the vegetation, rather than fly when startled. Fewer than 20 breeding sites are located in Massachusetts. Destruction of its wetland habitat is considered the primary cause of its decline.

The Common Loon spends summers nesting along the shores of lakes and ponds in New Hampshire, Maine, and Vermont, and migrates to coastal waters from the Chesapeake Bay to the Gulf of Mexico for the winter. Loons are large, heavy water birds, with wingspans approaching four feet. Red-eyed, with distinctive black and white markings, the loon has a dagger-like beak. Common Loons eat a broad range of fish species, including sticklebacks, young trout, and alewives, some aquatic invertebrates, particularly crustaceans, and occasionally aquatic plants. Loons leave the water only to nest on the ground very close to the shoreline. Their nests are often subject to predation by wolves, foxes, and martens. Large aquatic species such as northern pike and snapping turtles eat the chicks. Adult loons are at special risk from lead poisoning. Nearly 30% of dead loons retrieved near fresh water in Canada over the last decade had succumbed to lead poisoning. They may take baitfish from lines or eat fish that escaped the fishing line, swallowing both the bait and the lead sinker at the same time. They may also accidentally swallow lost lead sinkers when they search on lake bottoms for gizzard stones.

The Long-eared Owl is a slim, gray to brown-gray owl with blackish "ear" tufts, similar to the great-horned owl. The tufts are feathers that the owl uses to funnel sounds to the ear slits on the side of its head. The nocturnal owl forages predominantly at dusk, at dawn, and in moonlight on small mammals such as mice and voles. During the day, the owls roost in stands of pines and when disturbed, raise their ear tufts, compress their bodies and hide by disguising themselves as tree limbs or by blending in with the bark. Its preferred habitat is conifer stands in mixed woods near open fields. They prefer the abandoned nests of other birds and squirrels for nesting. The population seems to be declining due to loss of habitat from land development, forest thinning and the conversion of softwood forests to hardwood forests. Declining populations of their prey and decline in suitable nesting sites have also limited their numbers. Planting conifers such as red cedar, spruce and hemlock near fields or deciduous trees will provide the needed dense canopy the birds prefer. Preventing forest succession through field management will provide the habitat needed for the prey species. Protecting marshlands and grasslands and reducing use of pesticides will also improve the survival rate of the owls.

The Sharp-Shinned Hawk is slate-gray with a slim body, short broad wings, and a long, narrow, notched or square-tipped tail. The hawk has been particularly susceptible to the actions of humans over the last century. Pesticides used in the 1950's accumulated in the prey of the hawk, resulting in reproductive failure when the eggshells became too thin to withstand incubation, due to magnification of DDT levels along the food chain. At present, the eastern population is again declining, potentially as a result of acid rain and the use of Fenitrothion, a pesticide used to control spruce budworm. Further research is needed to determine the impacts of forest maturation, large-scale land use changes, and forest management and agricultural practices on the population and its breeding habits.

Adult grasshopper sparrows are small, chunky and gray-brown above, with buff sides and breast and a short, bristly tail. The head appears flat and the crown is dark, with a pale central stripe. The bird has a white eye-ring; and a yellow-orange spot between the eye and beak. They prefer large grassland areas of intermediate height with moderately deep litter and sparse coverage of woody vegetation. They breed in both native and tame grassland vegetation. The population has steadily declined as dry, grassy uplands and farms have reverted to forests or have been replaced by developments. Management practices such as burning, grazing, and mowing of grasslands affect the breeding habitat for the grassland birds. Early-season mowing of hayfields and other agricultural lands can result in major nest failure of grassland birds.

The Vesper Sparrow is gray-brown and streaked above, dull white below, and streaked on the throat, breast, and sides. The tail is short and notched with white outer feathers that are conspicuous in flight. Vesper sparrows nest on the ground in dry, grassy areas noted for sandy, rocky soils with patchy vegetation. With the dis-

appearance of farmlands and open fields and the increase in residential and commercial development, populations of vesper sparrows have declined. As with other ground-nesting birds, high numbers of predators, such as raccoons and skunks, and the parasitic cowbird, have also contributed to the decline of this species.

The Sedge Wren - formerly known as "Short-billed Marsh Wren," is a small bird with a brown back and buff under parts. The crown is brown streaked with white. It has an indistinct white eyebrow, a short, cocked tail, and a short, slender bill. It is distinguished from the Marsh Wren by its lack of a prominent eye stripe. Sedge Wrens generally nest in wet or dry grasslands, sedge meadows, planted cover, hayfields, lightly grazed pastures, and grassed waterways. They breed from late May through early June. The nest is built in sedges or rush-like grasses within 1 to 2 feet of muddy ground or shallow water. It is a well-hidden ball of woven grasses with an opening on one side. The interior is lined with cattail down, fur or feathers. Male sedge wrens often build additional "dummy" nests. The female can lay up to 2 clutches of 6 or 7 smooth, white, short, oval eggs per year. She incubates the clutch for 12 to 14 days. The bird has been considered a very rare migrant and sporadic nester in the state since the 1960s. The species is threatened by the loss of wetland habitats due to human development. The best way to maintain populations of the sedge wren is through the conservation and protection of sedge-marsh habitat. Programs involving wetland restoration may also help provide additional breeding and nesting locations for this species.

Fish

One rare fish species, the bridle shiner, lives in the warm, still, or slow-moving waters of streams, ponds, and rivers of the watershed. It is found over mud, silt, or debris in vegetated areas. The fish spawn in water about two (2) feet deep in openings surrounded by dense emergent vegetation, where there is no perceptible current. The eggs sink to the bottom and adhere to the vegetation. Water-hardened eggs are approximately 1.5 mm in diameter and hatch in fifty-seven (57) hours at seventy-five (75) degrees F. The newly hatched young, about 5 mm long, remain in the vegetation at first then begin to swim in small groups. By late July, they are in schools of one hundred (100) or more and by August when they are about their 22 mm standard length, they join schools of adult fish. They feed during daylight hours, in still water, primarily eating small insects, crustaceans, amphipods, water mites, mollusks, and plant materials and plankton on plant surfaces and the bottom.

Mussels

Two species of threatened freshwater mussels are found in watershed streams and rivers: the **Squawfoot Creeper**, and the **Triangle Floater**. They inhabit small to medium streams and rivers, burying themselves within mud, sand, silt, or gravel. They feed by filtering water for zooplankton, detritus, and small plants and animals. They improve water quality by straining particles and pollutants from rivers. Mussels are food sources for raccoons, muskrats, ducks, herons and fisheries.

Historically, fresh water mussels have been harvested for food and the nacre of their shells, which was used to produce pearl buttons. Today, in many states, they are still harvested to produce the tiny seed beads used in the Japanese cultured pearl industry to encourage pearl production in oysters.

Freshwater mussels serve as environmental indicators of the water quality of rivers, streams, ponds, and lakes. Freshwater mussels are towards the bottom of the food chain. Toxic contaminants from chemical spills, runoff from the application of herbicides, pesticides, and insecticides to fields, and other sources can be detected in their tissue. Predation of the polluted freshwater mussels could eventually lead to bio-magnification of the pollutant within the predator thus leading to the death of the predator.

Mussels are negatively impacted by pollution, siltation, recreational boat facilities, and some forms of timber harvesting. Pollution that adversely affects the host fish, which the mussels use in their reproductive cycle, would result in diminished numbers of mussels. Excessive siltation can decrease both mussel respiration and the amount of dissolved oxygen present within the water, which affects both the mussel community and other aquatic life that need the oxygen to survive. Creating impoundments and increasing water depths for boats results in decreasing water temperatures within the benthic region. Temperature decreases inhibit the reproduction cycle of freshwater mussels, delaying or preventing the cycle until the water temperature increases. This

delay reduces maturation time of the juvenile mussels, threatening their survival through the winter. Timber harvesting crushes or buries any mussels present when harvester machines ford streams without proper bridges.

Odonate (Dragonflies, Darners, Damselflies)
Several rare dragonflies inhabit the watershed: the Beaverpond Clubtail, the Brook Snaketail, the New England Bluet, and the Ski-Tailed Emerald

The Beaverpond Clubtail is a Gomphinid dragonfly, green at the thorax and black at the abdomen, which is only slightly clubbed. They live in mud-bottomed ponds, slow streams, and lakes. They breed in flowing water, where they are susceptible to pollution.

The Brook Snaketail is also a Gomphinid dragonfly, commonly referred to as a Clubtail. It is greenish, with a large, bulbous, superior abdominal appendage. The immature nymphs make their homes in warmer, slow-moving streams and the shallow waters of sheltered bays on larger lakes. The larvae burrow into silt, sand, or gravel along the edges of lakes or rivers. Dragonflies and damselflies are important in the food webs of freshwater streams and lakes. Dragonfly nymphs are an important source of food for trout. Dragonflies are also predators that consume large quantities of mosquitoes and other small flying insects. The nymphs feed under water on other invertebrates, but some large species may occasionally eat fish or tadpoles. The larvae are sensitive to changes in water flow and siltation.

The New England Bluet is a small, semi-aquatic damselfly, with a long slender blue abdomen and a blue head. Its wings are transparent and netted. Its preferred habitat includes ponds, lakes, bogs, and ponded sections of rivers with mucky edges and emergent vegetation. They are threatened by recreational and residential use of waters, pesticides, runoff, and projects to remove aquatic vegetation.

The Ski-Tailed Emerald is a medium-sized, slender dragonfly, generally dark brown with brilliant green eyes, and bright yellow thoracic markings. It is common to the northeast. They prefer slow to moderately flowing (often shady or boggy) streams, marshy beaver ponds and lake inlets or outlets. Generally seen from late May to late September, they feed high in the trees. Males hover along the shoreline, sometimes perching on twigs or grass. Females lay eggs in seepage pools.

The Spring Blue Darner (Spatterdock Darner) is a large (2.8 inches), blue-eye and brilliant blue-striped dragonfly that emerges in early summer. The species is threatened in Massachusetts. It requires spatterdock (yellow pond lily), a large plant with floating leaves, for breeding. Spatterdock Darner occurs in ponds, lakes and sluggish streams and seems to require relatively fish free ponds. Sometimes it can be seen at bog ponds. Females perch on the pond lily and lay their eggs on the underwater part of the stem. Continued survival of the Spatterdock Darner may be dependent on the activities of beavers.

Reptiles (Turtles)
Three rare species of turtle are found in the wetlands of the watershed: the Eastern Box Turtle, the Spotted Turtle, and the Wood Turtle. Spotted turtles inhabit a variety of wetland habitats in Massachusetts, including marshy meadows, wet woodlands, boggy areas, beaver ponds, and shallow muddy-bottomed streams. They can be found in Red Maple and Atlantic White Cedar swamps and woodland vernal pools. They require a soft substrate and prefer areas with aquatic vegetation. The Wood Turtle inhabits slow-moving streams with sandy bottoms and heavily vegetated stream banks. They nest in sandy, gravelly banks and hibernate in the bottoms and muddy banks in winter. They spend summers in the tangled vegetation of meadows and upland forests, returning to the streams in late summer to mate.

The greatest threats to the survival of the Eastern Box Turtle, the Spotted Turtle and the Wood Turtle include:

- Commercial exploitation by the pet trade;
- Pollution of streams;
- Increased development of wooded stream banks;
- Road construction and wetland alteration;
- Habitat fragmentation;
- Nest predation by nocturnal animals;

- Highway casualties of egg-laying females; and,
- Hay-mowing operations that destroy the tangled vegetation.

The Massachusetts Natural Heritage and Endangered Species Program recommends a number of strategies to protect these turtles. Enforcement of the Massachusetts Endangered Species Act should provide protection from the pet and biological supply trades. Timber harvesting should be restricted to frozen winter conditions. Forest cutting regulations under the Forest Cutting Practices Act (304 CMR 11.04 8G) should be strictly observed. Harvesting practices should include a fifty-foot no-cut buffer zone along the streams and rivers, erosion control measures, and use of portable or temporary bridges to avoid fording streams. Within a buffer of fifty to three hundred feet of streams inhabited by wood turtles, foresters should employ selective cutting instead of regeneration cutting. Timber harvesting equipment should be kept at least fifty feet from vernal pools during mud season. Vernal pools should be strictly protected from encroachment.

Rare Vascular Plants

Four rare plants have been sighted in the watershed: the Sand Violet, the Dwarf Mistletoe, the Bartram's Shadbush, and the Pod-Grass.

Sand Violet *(Viola Adunca, Viola Saggitata, Viola fimbriatula)* - Three different violets with differing scientific names have been commonly referred to as Sand Violet. Viola Adunca has also been called Small Blue Violet. Another name commonly associated with Viola Adunca is Dog Violet. Violets are difficult to identify because hybridization is common and plants intermediate in character between the two parent species are often found. Small blue violet is a tufted plant about three inches tall. It is a perennial plant that requires a semi-open canopy, in dry sandy pine and oak woods. The Natural Heritage program states that the violet prefers dry sandy clearings near open streams or lakes, and open, dry pine or aspen groves. The plant flowers from April through June with five to ten half-inch blue flowers that crown long-stalked leaves. These plants are also unusual in that two kinds of flowers are produced. In addition to the open, petal-bearing flowers, other flowers are closed and have no petals. These flowers are self-fertilized, produce most of the seeds, and sometimes form below ground. The plant is considered endangered in Massachusetts and only four official sighting have been recorded, all prior to 1979.

Dwarf Mistletoe *(Arceuthobium Pusillum)* - Dwarf mistletoe is a plant, but it is entirely dependent on its host tree. In response to branch infections, trees often produce "witches' brooms," abnormal proliferations of many small twigs which appear as a mass of twigs and foliage. Several dwarf mistletoe species infect Douglas Fir, Ponderosa Pine, Lodgepole Pine, Western Larch, Black Spruce, and Hemlock causing large witches' brooms. Death of the tree also means death of the mistletoe, so mistletoes tend to coexist with their hosts. Dwarf mistletoes are fairly host specific; there is limited crossover from one species of tree to another. Seeds are sticky and are forcibly shot up to 100 feet from shoots growing on swellings. When they land on the proper host, they sprout in the spring and penetrate the thin bark, forming a new infection. Shoots of the plant protrude from the swellings on branches and trunks. These are leafless and vary in color and size according to species; they have different male and female forms on the same tree.

In Massachusetts, Dwarf Mistletoe chooses black spruce, which grows in peatlands and wetland areas with coniferous trees and acidic water. It is considered rare in the state due to the sparse population of black spruce. In other regions of the country, dwarf mistletoe is considered a forestry management problem. To restore the population in Massachusetts, management activities should focus on increasing the black spruce population.

F. Areas of Critical Environmental Concern[28]

An Area of Critical Environmental Concern (ACEC) is an area containing concentrations of highly significant environmental resources that has been formally designated by the Commonwealth's Secretary of Environmental Affairs following a public nomination and review process. The formal designation of an ACEC directs state environmental agencies to take actions to preserve, restore and enhance the resources of an ACEC, and is intended to encourage and facilitate stewardship through the participation, cooperation, and expertise of communities, agencies, organizations, and individuals.

The ACEC Program was established in 1975, following legislation that authorizes and directs the Secretary of the Executive Office of Environmental Affairs (EOEA) to identify areas of critical environmental concern, and develop policies for their preservation and management. The first ACEC designated was the Cedar Swamp ACEC, located in Westborough and Hopkinton, in 1975. From 1975 to 1989, the Secretary designated two additional inland ACECs and 12 coastal ACECs. The Department of Environmental Management (DEM) has administered the inland ACEC program since 1989. Currently, there are twelve inland ACECs that total approximately 104,000 acres, and 14 coastal ACECs that include about 74,000 acres.

ACECs may include several kinds of environmental features, ranging from wetlands and water supply areas to rare species habitats and agricultural areas. To be eligible for designation, an area must contain at least four of these resource categories or features, and the resources and area must be of at least regional or statewide significance. The ecological interrelationships of the resources are just as important as the individual categories. Only by understanding and applying basic ecological principles to our environment can we expect to sustain and enhance our natural resources and quality of life.

At present, the Millers River watershed does not have any areas designated as ACEC's, though it may be a course of action for the Watershed team to investigate. High water quality (Class A designated areas), a large percentage of wetlands acreage, a significant volume of listed endangered species, extensive inland surface waters, natural hazard areas (Birch Hill Dam, Tully Dam), habitat resources, and special use areas are all examples of natural resources that would make an area qualified for status as an ACEC.

The ACEC Program works through the efforts of a large collaborative network of many individuals, communities, programs, agencies and organizations. After an ACEC has been designated, state environmental agencies are directed to administer programs, revise regulations, and review projects subject to their jurisdiction in order to preserve, restore, and enhance the resources of an ACEC. Municipalities, private organizations, and citizens are encouraged to apply high environmental standards to proposed development and to the management of critical resources in their own particular areas of responsibility and concern. Land stewardship programs like that of The Nature Conservancy and the efforts of local and regional land trusts are also used to preserve and manage significant land and resources. The process requires taking the time to understand and anticipate issues and interrelationships between people, environmental factors, and institutions. It also means taking positive actions as part of a long-term strategy rather than continually reacting to problems and crises.

The process of preparing a nomination is the first stage in educating people and raising consciousness about the environmental significance of an area, and the need for collaboration to protect and preserve it. If the Secretary accepts a nomination for full review, the public review of a nominated area continues this education process. The program includes public education programs and scientific research to promote understanding and sound stewardship of ACECs. Examples of these efforts range from elementary and secondary school environmental education programs that study the resources of a critical area as a "living laboratory" to ongoing water quality monitoring and testing programs undertaken by state agencies or environmental groups.
See Appendix B for a description of the ACEC Nomination process.

[28] Department of Environmental Management, http://www.state.ma.us/dem/programs/acec/regs.htm

III. Water Quality

Originally the waters of the Millers River were full of salmon, trout and other fish. European settlement of the region in the seventeenth century, with its accompanying development of dams and mills, began to change the quality and character of the water. In the 1930's and 1940's the river was still one of the best-stocked streams in the state. However, by the 1950's pollution from industrial and domestic sources had ruined the Millers for fishing and recreation. In the 1970's the local watershed council began orchestrating a cleanup. By 1983, the river was clean enough to stock again.

But pollution from PCB's, chlorination, heavy metals, erosion, landfill leachate, storm water runoff and acid rain continue to plague the watershed. The Department of Environmental Protection (DEP) conducts water quality monitoring for the Millers River watershed and publishes the data in periodic reports. The data supports environmental enforcement efforts for permitting compliance and provide useful information for measuring the contribution of non point sources of pollution.

The Otter River, from the Gardner Wastewater Treatment Plant to the confluence with the Millers River suffers from a condition of low dissolved oxygen, nutrient enrichment, and habitat alteration. Tully River and its east and west branches, and Lawrence Brook have been issues a Department of Public Health fish edibility advisory pertaining to the presence of mercury or PCB in edible fish fillets. Priest Brook has exhibited instream toxicity, low PH, and aluminum concentrations that consistently exceeded criteria for sustainability of aquatic life, despite having a watershed completely protected in a wildlife management area with no discharges or apparent land-based anthropogenic (man-made impact) sources of pollution. Low hardness and alkalinity are typical for waters in this area, and, therefore, subject them to potential impacts from atmospheric deposition.

Noxious aquatic plants are a prevalent problem for many of the lakes and ponds in the watershed. In these cases, the presence of non-native plant species, the percent cover of aquatic plants, and water transparency were all criteria used to evaluate lake conditions. The waterbodies affected by noxious aquatic plants or nutrients had native or non-native species in such abundance that they inhibited the other uses of the waterbody.

Federal and state legislation, passed in the 1960's and 1970's, greatly affected the treatment waste received before it was discharged into rivers and streams. The Federal Water Pollution Control Act of 1972 (Public Law 92-500) as amended by the Clean Water Act (CWA) of 1977 sought to eliminate discharge of pollutants into navigable waters by 1985 in order to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The Clean Water Act requires states to develop a monitoring program to analyze and report on the quality of water resources to the U.S. Environmental Protection Agency (EPA), the U.S. Congress, and the public every two years. The monitoring program is referred to as the 305(b) process.

The CWA establishes a set of four "fishable and swimmable goals" for all the nation's surface waters, as listed below:[29]

1. Provide suitable habitat for the survival and reproduction of a native, naturally diverse aquatic community.
2. Provide recreational opportunities with prolonged and intimate contact with the water, with a significant risk of ingestion of water.
3. Provide edible fish, shellfish, and other aquatic wildlife fit for human consumption.
4. Provide recreational opportunities in which contact with the water is either incidental or accidental, such as fishing and boating.

The Massachusetts Clean Water Act, enacted in 1966, specified laws, standards, and procedures for the implementation of federal legislation at the state level. It contained provisions for the regulation of discharge to surface waters, ground waters, and sewer systems, and provisions for state technical assistance to communities for construction of public treatment plants.

[29] Hoosic River Watershed Assessment Report, December 1998, p II-9.

To accomplish the Federal mandate, the Massachusetts Department of Environmental Protection (DEP) developed the five-year cycle watershed approach embodied in its statewide Watershed Initiative. The monitoring and reporting process is referred to as the 305(b) assessment report. Waterbodies are rated into several categories based upon the federal goals and state determined standards of water quality.

In 1995, the Massachusetts DEP developed its Surface Water Quality Standards (SWQS) in order to[30]:

- Designate the most sensitive uses for which the surface waterbodies of the Commonwealth shall be enhanced, maintained and protected;
- Prescribe minimum water quality criteria required to sustain the designated uses;
- Include provisions for the prohibition of discharges.

Listed below are five classes of uses and their sustenance criteria as defined in the SWQS:

Aquatic Life – the waters provide suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna. Three subclasses of aquatic life are also designated in the standards; Cold Water Fishery - capable of sustaining a year-round population of cold water aquatic life such as trout, Warm Water Fishery - waters which are not capable of sustaining a year-round population of cold water aquatic life, and Marine Fishery - suitable for sustaining marine flora and fauna.

Fish Consumption - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or shellfish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption.

Secondary Contact Recreation – the waters are suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities.

Primary Contact Recreation – The waters are suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.

Aesthetics - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

In an effort to restore the Millers River Watershed to a status of "fishable and swimmable waters" the DEP designated the uses of the surface waters in the Millers River Basin following the guidelines of the SWQS:

- Millers River – Class B, Cold Water Fishery, to the Winchendon Waste Water Treatment Plant (WWTP) and Warm Water Fishery below the Plant.
- Otter River – Class B Aquatic Life from its source to the Gardner WWTP and Class B Warm Water below the plant.
- Tully River – Class A public drinking water supply, aquifer recharge area from the confluence of its branches to its confluence with Millers River.

Lakes and ponds in the Millers River Watershed designated as a Class A Public Water Supply include: Upper Naukeag Lake in Ashburnham, Newton Reservoir in Athol, Phillipston Reservoir in Phillipston, Crystal Lake and Cowee Pond in Gardner, Perley Brook Reservoir in Gardner, Reservoirs No.1 and 2 in Athol, Lake Mattawa (North Pond Brook Reservoir) in Orange, and Lake Ellis (Ellis Pond) in Athol. The remaining lakes and ponds in the Millers River Basin are all designated as Class B Waters in accordance with the Surface Water Quality Standards (MA DEP 1995a). Thus, for the purpose of assessing the use support of the Millers River

[30] 1997 Millers River Watershed Resource Assessment Report, Introduction

Watershed lakes the following categories are included: fish consumption, aquatic life, swimmable (contact recreation), secondary contact and aesthetics.

Unlisted waters (tributaries) in the Millers River Basin not otherwise designated in the SWQS, are designated Class B, High Quality Waters. Where fisheries designations are necessary they shall be made on a case-by-case basis.

A. 303(d) Listed Waters

Under Section 303(d) of the Federal Clean Water Act, each State must submit a list of waters that are not meeting their water quality standards to EPA for review and approval every April of even years (e.g. 1996, 1998). The report lists several parameters of concern in measuring water quality. States must develop Total Maximum Daily Loads (TDMLs) for these concerns and establish pollution control strategies to restore the waters to meet water quality standards. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. It is the sum of the allowable loads of a single pollutant from all contributing point and non point sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonable variation in water quality. [31] At present, the Department of Environmental Protection is evaluating the potential sources of impairment for these reaches, and will eventually set standards for Total Maximum Daily Loads (TDMLs) for nutrients, organics, metals and other chemicals, and pathogens.

Parameters of Concern

Nutrients: Organic wastes and fertilizers introduce plant-feeding nutrients, such as nitrogen and phosphorous, into runoff. Common land use culprits include urban development, gravel operations, agriculture, and sewage disposal systems. When on-site sewage effluent or runoff enters a water body, excess nutrients cause eutrophication (excessive algal and dense weed growth) that disrupts the aquatic ecosystem and clogs rivers and streams. When these plants die, they deplete dissolved oxygen in the water important for fish and other forms of aquatic life. Moreover, algal blooms make water unpleasant to drink and smell, negatively impacting those who rely on the water body for drinking supplies and recreational/aesthetic values.

Heavy Metals (lead, copper, cadmium, zinc, mercury, aluminum, and chromium): Urban runoff, illegal dumping, poor storage practices, mining, and natural deposits contribute heavy metals to water bodies. Many types of common household products contain heavy metals. For example, most types of household batteries contain mercury and cadmium. Mercury is toxic to the human nervous system. Chronic breathing of mercury vapors can cause a range of physical symptoms, including the inability to coordinate body movement and hearing, speech and vision impairment. Exposure to mercury in other forms can lead to skin rashes and kidney damage. Cadmium exposure has been linked with kidney disease.

The most likely source of mercury in water systems is natural deposition from acid rain. Mercury is released to environmental media (air, water, soil) by a wide variety of natural processes and human interventions. There is a constant biogeochemical cycle of mercury. This cycle includes release of elemental mercury as a gas from the rocks and waters (degassing); long-range transport of the gases in the atmosphere; wet and dry deposition upon land and surface water; absorption onto sediment particles; and bioaccumulation in terrestrial and aquatic food chains. Worldwide, natural emissions of mercury from physical and biological processes may equal or exceed manmade emissions.

Urban runoff, illegal dumping, poor storage practices, mining, and natural deposits contribute mercury and other heavy metals to water bodies. Many types of common household products contain heavy metals. For example, most types of household batteries contain mercury and cadmium. As these batteries lose their charge they are routinely thrown away like paper products, eventually making it to landfills, where they corrode and deteriorate releasing the mercury into the soil. It is now illegal to manufacture or sell batteries containing mer-

[31] Source: http://www.epa.gov/iwi/303d/

cury in the United States. More than three years ago, the battery companies decided to voluntarily stop manufacturing mercury photo batteries for US consumption.

Other manmade discharges may result from industrial processes, such as: chlorine-alkali production, mining operations, paper mills, leather tanning, pharmaceutical production, and textile manufacture.

Mercury is less toxic in its volatile form, mercury-zero, than in organic compounds like methylmercury or inorganic salts (mercury-two). Mercury zero, however, is volatile, and thus can spread throughout the environment through secondary biological mechanisms. Once it reaches inland aquatic environments, mercury zero can again accumulate and be transformed into methylmercury[32], through the photochemical (abiotic) action of sunlight, through the methylcobalamin (a hydrocarbon compound) excreted by bacteria, and through the plants of aquatic ecosystems.

Human agricultural activities may release mercury to the soil through direct applications of organic and inorganic fertilizers (especially sewage sludge and compost), lime, and fungicides. Once in the soil, mercury compounds may undergo the same chemical and biological transformations found in aquatic systems. Elemental mercury (mercury zero) will form various compounds with the chloride and hydroxide ions of soils. The exact result will depend upon the pH, salt content, and other characteristics of the soil.

Bottom feeding organisms consume heavy metals with other food, and the heavy metals proceed through the food chain to affect other animals. Metals in the water tend to bioaccumulate in the tissue of fish (build up in concentration over time). Metals impact the reproductive rates and life spans of aquatic organisms, and hinder photosynthesis in aquatic plants. Effects on the water supply include increased treatment costs, reduction in the carrying capacity of pipes, water discoloration, and possible health hazards. Upon the discovery of heavy metals in fish tissue, fish consumption is restricted.

Priority Organics - These include chemicals such as polychlorinated biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs) and dioxin. They tend to accumulate in sediments and in fish flesh. In the sediment, chemicals can accumulate over time and produce higher levels for detection. Fish are affected both by the concentrations found in sediments and suspended in waters and by bioaccumulation and biomagnification up the food chain to predatory species. It is currently believed that the impacts are the result of historical pollution and not to current discharges.

Pesticides and Herbicides: Originating from agriculture, lawn care, golf courses, and urban runoff, pesticides and herbicides accumulate in sediments, posing risk to bottom feeding organisms and their predators. Like metals, pesticides and herbicides bioaccumulate in fish tissue, affect the reproductive rates and life spans of aquatic organisms, and hinder photosynthesis in aquatic plants. Many of these substances are carcinogens.

Pathogens: Microorganisms such as bacteria, viruses, and protozoa introduce waterborne illnesses to aquatic life. This, in turn, increases public health risks as well as treatment costs if discovered in drinking water supplies. While most pathogens come from human sewage (primarily leaking or aging sewage collection systems, on-site sewage systems, and combined sewer overflows), stormwater runoff, manure piles and animal wastes (both wild and domestic) are also common sources. Recent studies in coarse soils, such as those found on Cape Cod, showed viruses 2 feet—2,723 feet from the septic system where they originated (http://www.env.gov.bc.ca/).

Oxygen Depleting Substances: When organic wastes (i.e. manure, sewage, pulp, and paper mill effluent) decay in water, bacteria oxidize the waste, using up oxygen dissolved in the water. If the oxygen is consumed beyond

[32] Methylmercury is the form of mercury most available and most toxic to biota (including zooplankton, insects, fish, and humans). This form of mercury is easily taken up by biota and bioaccumulates in their tissues. Unlike many other fish contaminants, such as PCBs, dioxin, and DDT, mercury does not concentrate in the fat, but in the muscle tissue. Thus, there is no simple way to remove mercury-contaminated portions from fish that is to be eaten.

a safe threshold, fish are stressed and will die when lethal levels are reached. Anaerobic decomposition (without oxygen) produces gases, such as hydrogen sulphide, that are lethal to many organisms.

Salt: Comes from highway department storage and snow removal practices, including road maintenance and disposal of salt-laden snow. After salt is applied, it is washed off the pavement and carried into local waterways, increasing salinity. Accumulations of salt in small streams can harm human health if used as a drinking water source and can harm aquatic organisms and the ecology of the stream. Because salt is readily dissolved in water and can percolate through the soil into the groundwater, municipal water systems and private wells can be adversely affected. Salt along roadways also encourages the spread of phragmites or Common Reed and stresses salt intolerant trees and shrubs.

Sediments: Sediments result from runoff from a variety of sources including construction, roads, agriculture, logging, gravel operations, stream channelization, storm drains, and stream banks. Suspended soil particles make water turbid and unpleasant to drink, and reduce the recreation potential of water bodies for fishing, swimming and boating. In wetlands, sedimentation reduces flood storage capacity and increases peak discharges. Sediments destroy habitat, including feeding and spawning areas, by filling nest sites, river channels and wetlands. The amount of light available to algae and aquatic plants is reduced by sediments, which can damage fish gills and smother fish eggs. In addition to problems caused by volume, sediments may contain toxics and heavy metals that accumulate on riverbeds.

Other Habitat Alterations – Several natural and human induced conditions can adversely affect water quality and denigrate habitat. These include Atmospheric Deposition, Thermal Pollution, and Land Use Changes (discussed later).

- Atmospheric Deposition: Includes dust fall, acidic rainfall and air emissions. Water quality effects are primarily felt down-wind from urban areas, but long-range transport of persistent organic pollutants can occur. Pollutants released to the atmosphere from motor vehicles and other emissions eventually settle and enter waterbodies through runoff, rain and snow.

- Thermal Pollution: In addition to discharges from wastewater treatment plants, thermal pollution, or an increase in water temperature, can also occur because of urban runoff, construction, mining and gravel operations, logging, agriculture, and hydrologic changes. Thermal pollution harms fisheries by stunting their growth, reducing their resistance to disease, and reducing the amount of dissolved oxygen in water bodies. Sometimes, thermal pollution can cause the transition from cold water to warm water fisheries. It can also cause odors, affect water taste, and promote the growth of pathogens, bacteria, and nuisance vegetation.

The EPA assigns a unique identifying code to all monitored rivers, streams, ponds and lakes. The code enables the States and the Federal government to link information in its database.[33] about a given water body to a reference in a geographic information system. The 303(d) List of Impaired Waters in the Millers River Watershed, summarized in Tables III-1 and III-2, uses these codes for consistency between various water quality assessment efforts. Table III-1 lists the impaired rivers and streams by segment and the parameters of concern affecting them. Table III-2 lists the impaired ponds, lakes, and reservoirs, their trophic status, and the parameters of concern.

Table III-1: 1998 303(d) List of Impaired Rivers of the Millers River Watershed

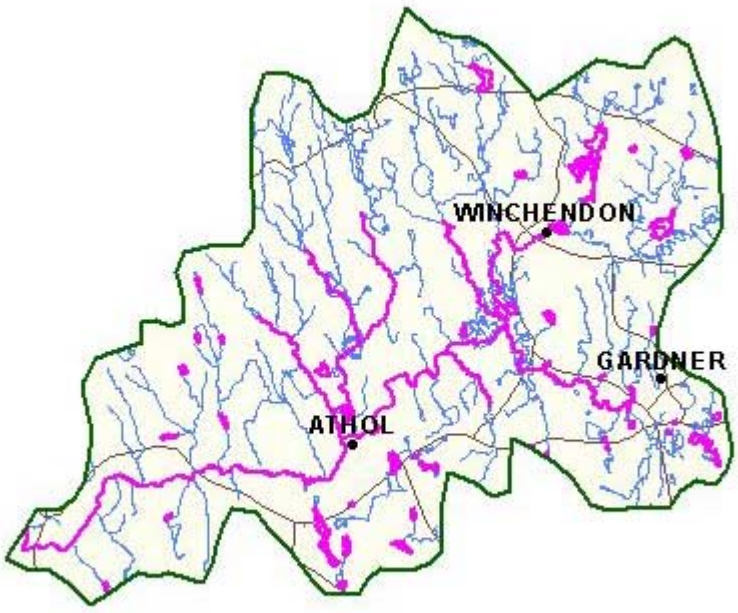
[33] The EPA Reach File Version 3-Alpha (RF3) is a national hydrologic database that uniquely identifies and inter-connects more than three million stream segments or "reaches" that comprise the country's surface water drainage system. RF3 was created from digital hydrography data (DLG) produced by the U.S. Geological Survey. EPA enhanced these hydrography datasets by assigning a unique reach code to each stream segment, determining the upstream/downstream relationships of each reach, and, when possible, identifying the stream name for each reach. A variety of other reach-related attributes that support mapping, pollutant routing, and spatial analysis applications are also available. EPA and USGS are currently finalizing the successor to RF3 that will have greatly improved accuracy and power, the National Hydrography Dataset (NHD).

ID - Waterbody	Parameter of Concern
MA35-01_1998 MILLERS RIVER from Whitney Pond in Winchendon to the Winchendon Wastewater Treatment Plant(2.0 miles)	Metals Priority Organics Nutrients Pathogens
MA35-02_1998 MILLERS RIVER from Winchendon Wastewater Treatment Plant to confluence with Otter Brook (5.3 miles)	Nutrients Unknown Toxicity Priority Organics Metals
MA35-03_1998 MILLERS RIVER from Otter Brook to a USGS gage station in South Royalston (4.8 miles)	Metals Nutrients Salinity/Tds/Chlorides Suspended Solids Priority Organics
MA35-04_1998 MILLERS RIVER from the USGS gage station in South Royalston to the Erving Paper Company (17.5 miles)	Priority Organics Metals Unknown Toxicity Pathogens Nutrients
MA35-05_1998 MILLERS RIVER From the Erving Paper Company to the Connecticut River backwater south of French King Bridge Erving	Metals Priority Organics
MA35-07_1998 OTTER RIVER from the Gardner Wastewater Treatment Plant outfall to the Seaman Paper Company Dam (4.3 miles)	Other Habitat Alterations Organic Enrichment/ Low Dissolved Oxygen Nutrients
MA35-08_1998 OTTER RIVER from the Seaman Paper Company to the confluence with Millers River and Trout Brook (5.5 miles)	Metals Other Habitat Alterations Pathogens Organic Enrichment/ Low Dissolved Oxygen Nutrients Priority Organics Salinity/Tds/Chlorides
MA35-09_1998 BEAVER BROOK From Templeton Developmental Center WWTP to confluence with Millers River, South Royalston	Pathogens Metals Priority Organics
MA35-10_1998 PRIEST BROOK Confluence of Scott and Towne Brooks to confluence with Millers River, Winchendon	Priority Organics Metals Unknown Toxicity
MA35-11_1998 WEST BRANCH TULLY RIVER from Sheomet Lake, Warwick, to its confluence with the East Branch (6.2 miles)	Priority Organics Metals
MA35-12_1998 EAST BRANCH TULLY RIVER from Tully Brook and Falls Brook to its confluence with the West Branch in Athol Center (10.5 miles)	Metals Unknown Priority Organics
MA35-13_1998 LAWRENCE BROOK	Priority Organics Metals Unknown
MA35-14_1998 TULLY RIVER from the confluence of its east and west branches to its confluence with Millers River (1.5 miles)	Priority Organics Metals

Source: Commonwealth of Massachusetts Department of Environmental Protection, Massachusetts Section 303(d) List of Waters

The Environmental Protection Agency maintains an interactive website of watershed characteristics based on several databases of water quality information. The data supports the production of a map that shows the reaches of the rivers and streams and several lakes and ponds that are listed on the state's 303(d) list of Impaired Waters. This map is shown in Figure 1.

Figure 1. Environmental Protection Agency Map of Impaired Waters on the 303(d) List



Legend

	CWA Section 303(d) Impaired Waters		RF3 Hydrography		8-digit USGS CU
	City		Highway/Primary Road		

Source: http://www.epa.gov/iwi/303d/01080202_303d.html

Lakes and ponds are classified by the amounts and kinds of organic materials produced and decayed from the processes of photosynthesis and decomposition. The classification is called the trophic status, and it affects the use value of the lake. Today, lakes are grouped into six classes of trophic status: Oligotrophic (low productivity), Mesotrophic (medium productivity), Eutrophic (high productivity), Hypereutrophic (saturated), dystrophic (naturally acidic), and Undetermined/Not attainable. The lake assessment for the Millers River watershed revealed that 18 of the lakes and ponds are in a mesotrophic state, 28 are in a eutrophic state, one is dystrophic, and 17 are as yet undetermined. Presumably additional testing of dissolved oxygen, chlorophyll, nutrients, and fecal coliform bacteria would corroborate that trophic status conditions are this advanced.

When there is a good balance between photosynthesis and decomposition, lakes and ponds are said to be oligotrophic. When the balance is upset between these two processes, either too much organic material accumulates without getting decomposed adequately or too many bacteria are present and an overabundance of decomposition occurs. Eutrophic lakes and ponds have an abundance of nutrients, and an abundance of

Table III-2: 1998 303(d) List Impaired Ponds and Lakes of the Millers River Watershed

Waterbody by Subwatershed	Town	Size (acres)	Trophic State	EPA ID	Parameter of Concern
North Branch Millers River					
Whites Mill Pond	Winchendon	38	E	MA35099_1998	Noxious Aquatic Plants
Lake Monomonac	Winchendon/Rindge, N.H.	292	M	MA35047_1998	Noxious Aquatic Plants
Upper Millers River					
Lower Naukeag Lake	Ashburnham	260	M	MA35041_1998	Noxious Aquatic Plants
Wallace Pond	Ashburnham	44	E	MA35092_1998	Noxious Aquatic Plants
Otter River					
Bents Pond	Gardner	31	U	MA35007_1998	Noxious Aquatic Plants, Turbidity
Cowee Pond	Gardner	20	M	MA35013_1998	Noxious Aquatic Plants
Hilchey Pond	Gardner	11	U	MA35029_1998	Turbidity
Kendall Pond	Gardner	22	M	MA35034_1998	Noxious Aquatic Plants, Organic Enrichment/Low Dissolved Oxygen
Parker Pond	Gardner	26	E	MA35056_1998	Noxious Aquatic Plants, Flow Alteration
Ramsdall Pond	Gardner	20	E	MA35062_1998	Noxious Aquatic Plants
Wrights Reservoir	Gardner/Westminster	128	U	MA35104_1998	Noxious Aquatic Plants
Bourn-Hadley Pond	Templeton	27	E	MA35008_1998	Noxious Aquatic Plants
Brazell Pond	Templeton	16	M	MA35010_1998	Noxious Aquatic Plants
Depot Pond	Templeton	17	E	MA35018_1998	Noxious Aquatic Plants
Greenwood Pond	Templeton/Westminster	25	E	MA35026_1998 MA35025_1998	Noxious Aquatic Plants
Minott Pond South	Westminster	30	E	MA35045_1998	Noxious Aquatic Plants
Minott Pond	Westminster	9	U	MA35046_1998	Noxious Aquatic Plants
Stoddard Pond	Winchendon	50	E	MA35083_1998	Noxious Aquatic Plants
Middle Millers River					
Lake Denison	Winchendon	82	M	MA35017_1998	Organic Enrichment/ Low Dissolved Oxygen
Whitney Pond	Winchendon	107	M	MA35101_1998	Noxious Aquatic Plants, Turbidity, Metals
Ellis Pond	Athol	67	E	MA35023_1998	Noxious Aquatic Plants
Reservoir No. 1	Athol	9	E	MA35063_1998	Noxious Aquatic Plants
Ward Pond	Athol	7	E	MA35093_1998	Noxious Aquatic Plants
Reservoir No. 2	Phillipston/Athol	54	E	MA35064_1998	Noxious Aquatic Plants
Tully River					
Beaver Flowage Pond	Royalston	58	E	MA35005_1998	Noxious Aquatic Plants, Turbidity
Royalston Road Pond	Orange	10	E	MA35071_1998	Noxious Aquatic Plants
Tully Pond	Orange	32	E	MA35089_1998	Noxious Aquatic Plants
Sportsman's Pond	Athol	102	E	MA35082_1998	Noxious Aquatic Plants
Lake Rohunta					
South Athol Pond	Athol	76	E	MA35078_1998	Noxious Aquatic Plants
Lake Rohunta North	Athol/Orange	63	E	MA35070_1998	Noxious Aquatic Plants
Lake Rohunta South	Athol/Orange/New Salem	70	E	MA35107_1998	Noxious Aquatic Plants
Riceville Pond	Athol/Petersham	68	E	MA35065_1998	Noxious Aquatic Plants
South Spectacle Pond	New Salem	37	D	MA35081_1998	Noxious Aquatic Plants
Davenport Pond	Petersham/Athol	32	E	MA35015_1998	Noxious Aquatic Plants
Gales Brook					
Gales Pond	Warwick	11	M	MA35024_1998	Turbidity
Hastings Pond	Warwick	20	U	MA35028_1998	Noxious Aquatic Plants
Moores Pond	Warwick	31	U	MA35048_1998	Noxious Aquatic Plants
Richards Reservoir	Warwick	30	E	MA35067_1998	Noxious Aquatic Plants
Wheelers Pond	Warwick	22	E	MA35097_1998	Noxious Aquatic Plants
Moss Brook					
Laurel Lake	Erving/Warwick	51	M	MA35035_1998	Noxious Aquatic Plants, Organic Enrichment/Low Dissolved Oxygen
Lower Millers River					
Bowens Pond	Wendell	11	M	MA35009_1998	Turbidity
Ruggles Pond	Wendell	19	E	MA35072_1998	Noxious Aquatic Plants

Source: Commonwealth of Massachusetts Department of Environmental Protection, Massachusetts Section 303(d) List of Waters

decay-causing organisms to break down all the organic material being produced. Their bottoms fill up with rich sediment. Sometimes there are so many bacteria, that oxygen is depleted and the waters become anoxic. Most inland lakes are eutrophic. In dystrophic lakes and ponds there is a lack of decomposition from bacteria and the nutrients build up. Bogs are an example of thick layers of peat moss and other plants building up because very little decay is taking place.[34]

Very few of the lakes showed evidence of non-native aquatic plants such as, Fanwort, Water Hyacinth, Variable Water Milfoil, and Eurasian Water Milfoil. Two species of non-native wetland plants were identified: Purple Loostrife found at the Lake Rohunta south basin, in Athol, and Common Reed Grass found at Bents Pond, in Gardner.

Recent assessments of toxicity levels in Millers River Watershed prompted the Massachusetts Department of Public Health to include Millers River and several lakes on its 1998 Freshwater Fish Consumption Advisory List. The list considers the content of toxic metals in the flesh of fish caught in the listed waters, and offers advisory warnings relative to the level of contaminant found in the species. Mercury and polychlorinated bi-phenyls (PCBs) are the two most prevalent contaminants found in the fish. Table III-3 describes the waters and lists the fish advisory codes for the fish caught there. Advisory code descriptions follow the table.

Table-III-3: Freshwater Fish Consumption Advisory List May, 2001

WATER BODY	TOWN(s)	FISH ADVISORY	HAZARD
Dennison, Lake	Winchendon	P1 Large Mouth Bass, P3 Large Mouth Bass	Mercury
Gales Pond	Warwick	P1 Yellow Perch, P3 Yellow Perch	Mercury
Millers River*	All towns from Erving to Winchendon	P1, P4 (all species), P2 Brown Trout & American Eel,	Mercury, PCBs
Rohunta, Lake	Orange, Athol, New Salem	P1, P5 (all species),	Mercury
Upper Naukeag Lake	Ashburnham	P1 Small Mouth Bass & Yellow Perch, P3 Small Mouth Bass & Yellow Perch	Mercury
Upper Reservoir	Westminster	P1, P5 (all species),	Mercury

Source: Massachusetts Department of Public Health, Bureau of Environmental Health Assessment
*The public should refrain from eating brown trout and eels from the Millers River below the confluence with the Otter River, and should limit consumption of all other fish species from the Millers River and its tributaries to two meals per month per person. Pregnant women, nursing mothers, and children under 12 years of age should not eat any fish from the Millers River and its tributaries.

Advice Codes

- P1 (all species) - Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this water body.
- P1 (species) - Children younger than 12 years, pregnant women, and nursing mothers should not eat any of the affected fish species (in parenthesis) from this water body.
- P2 (species) - The general public should not consume any of the affected fish species (in parenthesis) from this water body.
- P3 (species) - The general public should limit consumption of affected fish species (in parenthesis) to two meals per month.
- P4 - The general public should limit consumption of non-affected fish from this water body to two meals per month.
- P5 - The general public should limit consumption of all fish from this water body to two meals per month.

[34] http://www.twingroves.district96.k12.il.us/Wetlands/LakesPonds/LakesPonds.html

Currently, the Massachusetts DEP is funding an ongoing study to determine the extent of the PCB problem in the Millers River. At the early stages of the project it appears as if the PCB problem originates in the Baldwinville stretch of the Otter River in an area where historically both an electric light and a paper recycling facility used PCB's in their manufacturing processes.

The Massachusetts DEP Division of Watershed Management (DWM) drafted the Millers River Watershed Resource Assessment Report in 1995, (updated draft in 1997), providing historical perspective from an intensive survey conducted in 1987, and reporting the findings of the 1995 Monitoring Program. Table III-4 summarizes water quality testing results from the Draft Watershed Resource Assessment Report updated in 1997. The table provides ratings for aquatic life and fish consumption and also identifies its overall ranking. As of the most recent draft of the assessment, Primary Contact (e.g. swimming) and Secondary Contact (e.g. boating) have not been assessed. Despite a Class B status for these waters, there is an advisory against fish consumption, and in a five-mile section of the river, PCB's negatively impact populations of aquatic life. The classification of rivers and streams in Massachusetts does not necessarily mean that the river meets that classification. The stated class for a particular river is in fact only the State's goal for that river.

According to the Housatonic Valley Association, an organization working for the cleanup of the Housatonic River in Berkshire County, PCBs can last in sediments for centuries. Cleanup treatments depend on the extent of the contamination. In some cases, PCBs, which are heavy metals, collect together into contaminant plumes where they slowly move through sediments like oil. Dredging may be the best solution in that case. However, where the contamination is not nearly as severe, allowing river sediments to bury the PCBs naturally may be more reasonable. Dredging is very expensive and can end up mixing contaminated sediments throughout the river ecosystem. Until the PCBs are cleaned-up or dealt with in a manner that reduces their impact to people, wildlife, and fisheries, the wildlife and recreational benefits of the Millers River will not be fully realized.

The information presented in the table on aquatic life and fish consumption may appear to be in conflict. It is possible for a river segment to be interpreted as having a "non-support" rating for fish consumption and a "full support" status for aquatic life use. Although this appears as conflicting, the two interpretations are the results of different testing methods and assumptions made by EPA. For example, when fish flesh is measured for contamination, many species of fish are tested, and not all are found to contain mercury or PCBs. It is assumed that because PCBs are not found in other fish species, the presence of PCBs in any fish does not immediately infer that all aquatic life is threatened. In fact the Massachusetts Department of Public Health's fish advisories are very specific. The fish advisory identifies only the species that are likely contaminated and suggests consumption limits for discreet segments of the citizenry (i.e. pregnant women and children).

Other testing methods are used to determine the level of support for the "aquatic life" use. Both acute toxicity and chronic toxicity tests are applied with different methods. The acute toxicity tests measure levels of certain metals like aluminum, copper, and lead downstream of point sources of pollution like wastewater treatment plant discharges. The acute toxicity test compares these levels found to permit criteria. The chronic toxicity testing methods measure changes to normal growth levels for indicator species like the fathead minnow. Therefore, acute toxicity test results in a segment downstream of a discharge pipe might show levels of copper, which exceed the criteria of the company's permit but, if the minnows are growing normally with no signs of toxicity, then the segment would receive a full support for aquatic use.

According to the MDEP, a significant portion of the Millers and Otter Rivers upstream from Athol received a rating of Non-support for Aquatic Life. This means that contaminants in the water were found to have a negative impact on the growth of indicator fish species. Where the segments of the Millers and Otter rivers had a Non-Support or a Full Support/Threatened rating for Aquatic Life, the cause of the rating was often inferred. These sources of contaminants are referred to as “point sources” of pollution because the pollutants can be traced to a discreet outflow pipe, or point. These potential point sources of pollution include Winchendon Wastewater Treatment Plant, L.S. Starrett Co., Gardner Wastewater Treatment Plant, and Seaman Paper Co.

Table III-4: Summary Table of Testing Results for the Millers River

Location	Aquatic Life	Fish Consumption	Overall Ranking of Segment
MA 35-01 Millers River from Whitney Pond in Winchendon to the Winchendon Wastewater Treatment Plant (2.0 miles)	Full Support Although levels of aluminum, copper, and lead exceeded criteria frequently, the chronic toxicity test showed no significant toxic effects and so the segment is listed as "full support" for the aquatic life use.	Non-Support High levels of mercury and polychlorinated biphenyls (PCBs)	Class B This two - mile segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-02 Millers River from Winchendon WWTP to confluence with Otter River (5.3 miles)	Non-Support (5.3 miles) Environmental Protection Agency (EPA) tests showed no survival in fathead minnows, which the EPA interpreted as "not supporting" the aquatic life use. It is suspected that water quality problems are related to atmospheric deposition.	Non-Support High levels of mercury and polychlorinated biphenyls (PCBs)	Class B This segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-03 Millers River from Otter River to a USGS gage station in South Royalston (4.8 miles)	Not Assessed	Non-Support High levels of mercury and polychlorinated biphenyls (PCBs)	Class B This segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-04 Millers River from the USGS gage station in South Royalston to the Erving Paper Company (17.5 miles)	Full Support (16.5 miles) Threatened (1.0 mile) Discharge from L.S. Starrett Co. in Athol exceeded permit limits for acute toxicity two out of six times. These results are interpreted as "threatening" the segment for one mile downstream from the discharge.	Non-Support High levels of mercury and polychlorinated biphenyls (PCBs)	Class B This segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA35-05_1998 Millers River from the Erving Paper Company to the Connecticut River backwater south of French King Bridge Erving	Full Support (8.1 miles) Municipal and industrial point sources affect this segment. In some instances, Millers Falls WWTP exceeded chronic toxicity tests for metals.	Non-Support High levels of mercury and polychlorinated biphenyls (PCBs)	Class B This segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-06 Otter River from wetlands in Hubbardston and Templeton to the outfall at the Gardner Wastewater Treatment Plant (2.6 miles)	Full Support (2.6 miles) Threatened (2.6 miles) Low ratings for dissolved oxygen and percent saturation are attributed to natural wetlands conditions. Yet EPA toxicity tests indicated significantly lower growth rates in Fathead minnows.	Threatened The source and cause of the threat is unknown.	Class B This segment should be added to the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-07 Otter River from the Gardner Wastewater Treatment Plant outfall to the Seaman Paper Company Dam (4.3 miles)	Non-support (4.3 miles) Super-saturation of dissolved oxygen due to increased primary productivity, coupled with high nutrient values indicates enrichment. Gardner WWTP is not meeting the copper limit and seems to have lead problems.	Full Support	Class B This segment should remain on the 303 (d) list of impaired water bodies based on Dept. of Health Fish Advisory

Table III-4: Summary Table of Testing Results for the Millers River (Cont.)

Location	Aquatic Life	Fish Consumption	Overall Ranking of Segment
MA 35-08 Otter River from the Seaman Paper Company to the confluence with Millers River and Trout Brook (5.5 miles)	Non-Support (5.5 miles) Low dissolved oxygen rates in early morning and super-saturation during daylight coupled with high nutrient values indicate enrichment. Tests indicate significant toxicity below the Templeton WWTP and the Seaman Paper Co. (0.5 miles)	Non-Support Chronically high levels of aluminum, copper, zinc and lead resulting from the treatment plant and Seaman Paper Co.	Class B This segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA35-09_1998 Beaver Brook From Templeton Developmental Center WWTP to confluence with Millers River, South Royalston	Not Assessed	Non-Support High levels of mercury and polychlorinated biphenyls (PCB's)	Class B This segment should remain on the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA35-10_1998 PRIEST BROOK Confluence of Scott and Towne Brooks to confluence with Millers River	Non-Support (7.4 miles) Instream toxicity tests showed complete mortality over a 48-hour period. Low hardness and alkalinity may be due to atmospheric deposition.	Non-Support High levels of mercury and polychlorinated biphenyls (PCB's, and unknown toxicity.)	Class B This segment should be added to the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-12 East Branch Tully River from Tully Brook and Falls Brook to its confluence with the West Branch in Athol Center (10.5 miles)	Non-Support (10.5 miles) Rapid Bioassessment Protocol II indicated moderate impairment, which is interpreted as non-support for aquatic life. The source of impairment is unknown.	Non-Support High levels of mercury and polychlorinated biphenyls (PCB's)	Class B This segment should be added to the 303(d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-11 West Branch Tully River from Sheomet Lake, Warwick, to its confluence with the East Branch (6.2 miles)	Full-Support (6.2 miles) This was the reference station for the bioassessments and so it was assumed to be fully supported	Non-Support High levels of mercury and polychlorinated biphenyls (PCB's)	Class B This segment should be added to the 303 9d) list of impaired water bodies based on Dept. of Health Fish Advisory
MA 35-14 Tully River from the confluence of its east and west branches to its confluence with Millers River (1.5 miles)	Not Assessed	Non-Support High levels of mercury and polychlorinated biphenyls (PCB's)	Class B This segment should be added to the 303 9d) list of impaired water bodies based on Dept. of Health Fish Advisory

Source: 1997 Millers River Watershed Draft Assessment Report; Massachusetts Department of Environmental Protection.

From 1970 to 1980, the twelve-mile stretch of the Otter River from its source to Millers River was rated as Class C. This classification designated the river for uses of protection and propagation of fish and other aquatic life, and protection of wildlife habitat. Improvements in water quality from 1980 to 1990 raised the rating to Class B and the river was considered suited for secondary contact recreation such as boating and fishing.

Numerous water quality surveys conducted over the years identified water quality problems and document improvements. Water quality data from the 1987 survey showed that upgrading and constructing wastewater treatment plants (WWTPs) have improved the water quality in the Millers River watershed considerably; however,

they still contribute the largest loading of pollutants to the waters of the basin. Therefore, the water quality of the Millers River watershed is largely dependent upon the proper operation of the treatment plants.[35]

The 1987 survey indicated that the Otter River still had dissolved oxygen concentrations below the water quality standard of 5 mg/l. The Otter River's low assimilative capacity and high wastewater input from three National Pollution Discharge Elimination System (NPDES) permit holders suggest that the renewal of their NPDES permits will have to be reviewed carefully. The NPDES permit for the Gardner Publicly Owned Treatment Works was issued in 1992, and they have been de-chlorinating their effluent since 1987. Seaman Paper Company was issued an amended NPDES permit in 1994; they have significantly improved their secondary treatment since 1987. The NPDES permit for the Templeton Waste Water Treatment Plant was issued in 1991; they now accept, for profit, industrial wastewater on a regional basis.

In 1995, the Massachusetts Department of Environmental Protection (MDEP) conducted a new survey of water quality in the Millers River Watershed. The survey revealed that the Otter River, while improving, is still a significant source of pollutants to the Millers River. The water quality assessments included instream toxicity tests conducted by the Environmental Protection Agency, monitoring of the aquatic community following Rapid Bioassessment Protocols[36] to determine if a stream is supporting or not supporting a designated aquatic life use, and review of discharge monitoring reports (DMRs) of NPDES permit holders.

The Otter River was divided into three segments and seven monitoring stations were set up. All stations were sampled monthly from June 1995 through August 1995. EPA instream toxicity tests were run at all stations in August 1995. Bioassessment samples were collected in August 1995. Effluent data from the Gardner WWTP discharge monitoring reports were reviewed. Ambient water test results from Seaman Paper Company (August, 1992 - March, 1997) and Templeton WWTP (July, 1991 - January, 1997) discharge monitoring reports were reviewed. Table 3 summarizes the water quality testing results and lists the analyses for each segment.

Otter River Upper (Segment MA 35 - 06); 2.6 miles - Station M01 is located on this reach. From it's beginning in Hubbardston and Templeton, the river meanders through a large wetland area. Passing under Routes 2 and 2A in Gardner, and then through a portion of Templeton again, the reach ends at the site of the outfall from the Gardner WWTP. Aquatic life on this segment is threatened, as evidenced by EPA toxicity tests that showed significantly lower growth rates in fathead minnows. The cause is unknown but the threat may reflect natural conditions unrelated to discharge or habitat alteration. It was recommended that additional monitoring be done for fecal coliform bacteria. Further research is needed to confirm the natural sources of low dissolved oxygen.

Otter River (Segment MA 35 - 07); 4.3 miles - Stations M02 and M03 are located along this reach. The segment begins at the Gardner WWTP outfall and forms the boundary between Gardner and Templeton as it flows past several large sand and gravel operations. Immediately downstream from the USGS gage at Turner Street the river enters Templeton proper, and flows into the impoundment behind the Seaman Paper Company dam that marks the end of the reach. Aquatic life is not supported in this reach of the river due to organic enrichment and low dissolved oxygen, excessive nutrient load and undetermined habitat alterations. Sources of impairment are a municipal point source and unknown sources. Additional monitoring is needed to determine the extent of the influence the Gardner effluent has on dissolved oxygen and biological communities, the frequency and extent of the effects of sand and gravel operations on the bio-community. More stringent analysis of bioassessment data would help to determine the level of impairment. It was recommended that the segment be added to the State's 303(d) list of impaired waters.

[35] 1997 Millers River Watershed Assessment Report; Massachusetts Department of Environmental Protection.

[36] The Rapid Bioassessment Protocols (RBPs) are a synthesis of methods employed by various State Water Resource Agencies. Protocols cover environmental conditions for periphyton, benthic macroinvertebrates, and fish. Rapid Bioassessment Protocols are used to characterize the existence and severity of impairment to the water resource, identify sources and causes of impairment, Evaluate the effectiveness of control actions and restoration activities, support use attainability studies and cumulative impact assessments, and characterize regional biotic attributes of reference conditions.

Otter River (Segment MA 35 - 08); 5.5 miles - Stations 04, 05, 06 and 07 are located along this reach. From the Seaman Paper Company dam the river flows through a short rapids section before slowing again and entering the impoundment formed by the partially breached dam at the old Baldwinville Products Mill. Just downstream from here the river receives effluent from the Templeton WWTP. From here the river flows more rapidly through the Village of Baldwinville, but slows again downstream in a wetland area of Otter River State Forest. As the Otter River meanders northward it is joined by Trout Brook. The segment ends at its confluence with the Millers River in Winchendon. Polychlorinated Biphenyl (PCB) pollution, excessive nutrients, excessive heavy metals, organic enrichment and low dissolved oxygen, as well as habitat alteration, have resulted in a non-support rating for aquatic life and fish consumption. Portions of the segment are aesthetically impaired, as well. Sources of impairment include a municipal point source, an industrial point source, and contaminated sediments. Additional monitoring to determine the extent of influence of the discharges, and more stringent analysis of bioassessment data would help to quantify the level of impairment. It was recommended that the segment remain on the 303(d) list of impaired waters.

Tully River was divided into four segments, and four monitoring stations were set up. On the East Branch Tully River, Segment MA 35-12, two stations were established: TE01 located upstream from Fryeville Road, in Athol /Orange, and TE02 located upstream from Tully Road, in Athol / Orange, just above the confluence with the West Branch Tully River; at the Pinedale Ave./Tully Road Bridge. On Lawrence Brook, Segment MA 35-13, one station was established: LB1 located upstream from Doane's Falls and Athol Road, Royalston. On the West Branch Tully River, Segment MA 35-11, one station was established: TW01 located upstream from Tully Road, Orange. On Tully River, Segment MA 35-14 there was no monitoring station.

East Branch Tully River, (Segment MA 35 - 12); Size: 10.5 miles The East Branch Tully River is formed by the confluence of Tully Brook and Falls Brook in Royalston State Forest. It flows southwestward for approximately three miles before entering Long Pond and Tully Lake; the latter formed by Tully Dam, built and operated by the US Army Corps of Engineers. From the dam the river flows south and then west, forming the boundary between Orange and Athol for most of the distance, to its confluence with the West Branch in Athol Center. Two stations (TE01, TE02) were sampled for bioassessment purposes on September 5, 1995. TE02 was located just above the confluence with the West Branch Tully River; at the Pinedale Ave./Tully Road Bridge. TE01 was located further upstream at the Fryeville Road bridge.

Lawrence Brook, (Segment MA 35 - 13); Size: 8.5 miles This segment begins at the MA-NH state line, although Lawrence Brook actually originates at the outlet of Sportsman Pond in Fitzwilliam, NH. Almost immediately downstream from the state line the brook enters a large wetland where it meanders southward, then to the west, and finally northward. As it finally flows in a southerly direction once again, it meets several small tributaries and the velocity increases with gradient. Just south of Northeast Fitzwilliam Road Lawrence Brook enters another wetland, where it flows slowly until it reaches Doane's Falls immediately west of Athol Road. Here the stream drops almost 150 feet before entering Tully Lake (East Branch Tully River).

West Branch Tully River, (Segment MA 35 - 11); Size: 6.2 miles

The West Branch Tully River originates in Warwick, MA at the outlet of Sheomet Lake, which is, itself, fed by Tully Brook. The river flows rapidly southeastward to Tully Meadow in orange where it is joined by Collar Brook. From here the river flows more southerly while slowly passing through a wetland area just west of Tully Mountain. Downstream, the West Branch and East Branch Tully rivers conjoin at the Orange-Athol corporate boundary.

Tully River, (Segment MA 35 - 14); Size: 1.5 miles

The Tully River forms at the confluence of its east and west branches at the Orange-Athol corporate boundary. From there it flows southward through a wetland for 1.5 miles before it empties into the Millers River, just north and west of the center of Athol. It meets several small tributaries along its course. The Department of Public Health fish edibility advisory is the only information used to make this assessment.

Bioassessment samples were collected in September of 1995 at all four stations. Station TW01 on West Branch Tully River was used as a reference station for the Millers River bioassessments so aquatic life use was assumed to

be “fully supported.” Low flow was noted at this station when sampling was conducted. The habitat score was somewhat reduced, but the biological community was excellent. Apparently no EPA instream toxicity tests were run for the assessment. Rapid Bioassessment Protocol II (RBP II) results indicated moderate impairment at all stations (excluding the reference station), which is interpreted as “non-support” for aquatic life. There is a Department of Public Health fish advisory in effect for all segments, due to mercury and PCB in fish flesh so all the segments are listed as “not supporting” for the fish consumption use. The causes of impairment are PCB and mercury from unknown sources.

The Draft Water Quality Assessment Report recommended that existing and future bioassessment data from these sites should be analyzed using RBP level III to better ascertain the impacts. Instream toxicity tests should be done. Additional monitoring is needed, including Hydrolab, bacteria and water chemistry testing, to fully assess the use support status. All these segments should be added to the 303(d) list.

IV. Land Use Characteristics

Most of the nonpoint sources of pollution can be traced back to land use practices that allow pollutants to settle into the ground, permeating soils and run over the surface of the landscape to enter surface waters. Lands under agricultural management can be associated with excessive levels of nutrients such as nitrogen and phosphorus. Livestock can generate excessive amounts of manure that gets washed into streams, rivers and ponds. Non-sustainable agricultural and forestry practices can lead to excessive erosion that results in siltation and sedimentation. By contrast, developed land is increasingly impervious to surface water and rainfall. As more of the land is paved over or converted to structures, the ability of the ground to absorb stormwater is diminished, resulting in increased flood potential. As rainwater flows over the impervious surfaces, it picks up sediments and chemicals and carries them to surface waters.

A. Existing Land Use

According to land use data for 1999, distributed by the Massachusetts Geographic Information System (MassGIS), the Millers River Watershed in Massachusetts encompasses 310 square miles 198,669 square acres. Most of the watershed area is undeveloped, at eighty six percent of the total land area (or 171,046 acres). Approximately 21,344 acres of land is developed and represents eleven percent of the total land area. Agriculture is limited in the watershed. Most farms are small, encompassing less than fifty acres on average. Agricultural uses such as cropland, pasture, orchards, and nurseries represent only 3.5% of the land area or 6,958 acres. A summary of land use by subwatershed is listed in Table IV-1.

The land use datalayer catalogues land use into 21 broad categories. Both the patterns of land use and the nature and intensity of use affect water quality. Using ArcView® GIS software (by Environmental Systems Research Institute, Inc.) and data layers from the MassGIS library, a land use map was created for the watershed. The Land Use map shows the location of the major land use classes described in Table IV-2.

Over ninety percent (156,738 acres) of the undeveloped land is forested. The remaining 9.6% (16,420 acres) is comprised of wetlands and water.) Most of the undeveloped land is located in the Upper, Middle, and Lower Millers River subwatersheds and the Otter and Tully River subwatersheds. Residential uses account for seventy four percent of developed lands, at 15,816 acres. Predominant residential land uses are lots greater than ½ acre in size. Over sixty-five percent of residential acreage falls into this category. Multi-Family residential uses are confined to the urbanized areas in the Otter River, Middle Millers and Lower Millers River subwatersheds.

Commercial, Industrial, Transportation, and Waste Disposal uses account for twenty-six percent, or 5,528 acres. Most of this development is located in the Otter River and Middle Millers River Subwatersheds in the communities of Gardner, Templeton, Athol, and Orange. These urban areas account for sixty seven percent of the developed lands throughout the watershed. Of these lands, over fifty-one percent are in the Otter River and Middle Millers River Subwatersheds.

The least developed areas are the subwatersheds of smaller tributaries to the Millers River and Tully River. Whetstone Brook flows along the rural boundary of Wendell, northwest of the Quabbin Reservation. Scott/Priest Brook flows south along the border of Royalston and Winchendon joining the Millers River in the Birch Hill Dam area. Lawrence Brook flows southwest through Royalston to Tully Lake.

The subwatersheds with the greatest acreage of wetlands and open water are also the areas with the highest populations and the greatest intensity of land uses. These include the Otter River, Upper and Middle Millers, Tully River and Lake Rohunta subwatersheds. This pattern reflects a historical interest in locating near water and level terrain. Table IV-3 lists the allocation of land uses by subwatershed.

Table IV-1: Summary of Land Use in Millers River Watershed by Subwatershed

Subwatershed	Undeveloped Land*		Developed Land**		Agricultural Land***	
	Acres	%	Acres	%	Acres	%
1 North Branch Millers River	1,213	0.7%	156	0.7%	9	0.2%
2 Upper Millers River	15,732	9.2%	1,491	7.0%	159	2.5%
3 Otter River	30,116	17.6%	8,042	37.7%	1,294	20.6%
4 Middle Millers River	32,351	18.9%	6,401	30.0%	1,939	30.9%
5 Tarbell Brook	3,233	1.9%	488	2.3%	92	1.5%
6 Scott/Priest Brook	6,057	3.5%	133	0.6%	92	1.5%
7 Lawrence Brook	8,637	5.0%	263	1.2%	318	5.1%
8 Tully River	19,969	11.7%	1,081	5.1%	860	13.7%
9 Lake Rohunta	11,483	6.7%	1,155	5.4%	331	5.3%
10 West Brook	5,121	3.0%	340	1.6%	395	6.3%
11 Gales Brook	5,937	3.5%	281	1.3%	242	3.8%
12 Moss Brook	7,408	4.3%	255	1.2%	162	2.6%
13 Whetstone Brook	3,314	1.9%	36	0.2%	-	0.0%
14 Lower Millers River	20,476	12.0%	1,220	5.7%	387	6.2%
Subwatershed Total	**171,046**	**100%**	**21,344**	**100%**	**6,280**	**100%**
Percent of Millers River Watershed		86%		11%		3%

Source: MassGIS 1999 Land Use Datalayer

*Undeveloped Land = forest, wetland, open land, water. **Developed Land = Mining, all residential development, commercial, industrial, urban open land, transportation, and waste disposal. ***Agricultural Land = cropland, pasture, orchard, and woody perennial.

Table IV-2: Millers River Watershed Land Use Acreage

Land Use Code	Land Use Category	Acres	% of Total Land Area
1	Cropland (Intensive Agriculture)	3,271	1.6%
2	Pasture (Extensive Agriculture)	2,760	1.4%
3	Forestland	154,615	77.8%
4	Wetland (Non-forested freshwater)	6,052	3.0%
5	Mining (Sand, Gravel, and Rock)	1,191	0.6%
6	Open Land (Abandoned agriculture, areas of no vegetation)	3,698	1.9%
7	Participation Recreation (Golf, Tennis, Playgrounds, skiing)	935	0.5%
8	Spectator Recreation (Stadiums, racetracks, fairgrounds, drive-ins)	19	0.0%
9	Water Based Recreation (Beaches, Marinas, Swimming Pools)	39	0.0%
10	Residential Multifamily	182	0.1%
11	Residential < 1/4 acre lot	1,237	0.6%
12	Residential 1/4 - 1/2 acre lot	4,025	2.0%
13	Residential > 1/2 acre lot	10,372	5.2%
15	Commercial (General Urban, shopping center)	749	0.4%
16	Industrial (Light and Heavy Industry)	881	0.4%
17	Urban Open (Parks, public & institutional green space, vacant land)	1,366	0.7%
18	Transportation (Airports, docks, divided highway, freight storage, railroads)	1,257	0.6%
19	Waste Disposal (Landfills, sewage lagoons)	457	0.2%
20	Water (Freshwater, coastal embayment)	5,316	2.7%
21	Woody Perennial (Orchard, Nursery, Cranberry bog)	248	0.1%
	Total Land Area	**198,669**	**100%**

Source: MassGIS 1999 land Use Datalayer

Map: Land Use in the Millers River Watershed

Table IV-3: Millers River Watershed 1999 Land Uses by Subwatershed

Land Use Category	1 North Branch Millers River	2 Upper Millers River	3 Otter River	4 Middle Millers River	5 Tarbell Brook	6 Scott/Priest Brook	7 Lawrence Brook	8 Tully River	9 Lake Rohunta	10 West Brook	11 Gales Brook	12 Moss Brook	13 Whetstone Brook	14 Lower Millers River	Total Acres	% of Total Land Area
1 Cropland	7	38	667	1,064	76	36	159	600	142	259	50	49		126	3,271	1.6%
2 Pasture	3	111	576	746	16	56	159	248	177	108	189	113		260	2,760	1.4%
3 Forestland	998	13,320	26,033	29,313	2,981	5,627	7,946	18,306	10,139	4,807	5,582	7,053	3,215	19,292	154,615	77.8%
4 Wetland		888	1,356	883	179	322	515	605	443	88	193	223	58	298	6,052	3.0%
5 Mining		109	812	179	14	3	10	14	24		5		9	13	1,191	0.6%
6 Open Land	25	386	1,115	701	47	106	146	326	138	91	66	45	41	465	3,698	1.9%
7 Participation Recreation		47	319	342	2	2	4	5	157		21	14		22	935	0.5%
8 Spectator Recreation			19												19	0.0%
9 Water Based Recreation		2	14	15		2		0	1			3			39	0.0%
10 Residential Multifamily			76	81	7			4						13	182	0.1%
11 Residential < 1/4 acre lot			782	327	32			17		0				78	1,237	0.6%
12 Residential 1/4 - 1/2 acre lot		245	1,501	1,740	44			214	87	28	4	42		121	4,025	2.0%
13 Residential > 1/2 acre lot	155	1,026	2,870	2,514	318	126	228	793	847	275	240	196	24	761	10,372	5.2%
15 Commercial		32	317	314	13		3	1	4	37	4			23	749	0.4%
16 Industrial	2	1	443	298	30		14	22	7		7			57	881	0.4%
17 Urban Open		30	521	440	24	1	26	81	89	22	1	8		122	1,366	0.7%
18 Transportation		2	676	508	13				17					41	1,257	0.6%
19 Waste Disposal		26	213	83	13		5	11	12				4	90	457	0.2%
20 Water	189	1,107	1,090	1,013	2	1	5	650	674	112	93	78		299	5,316	2.7%
21 Woody Perennial		11	51	129				12	12	28	3			1	248	0.1%
Total Acres	**1,378**	**17,381**	**39,453**	**40,692**	**3,813**	**6,282**	**9,218**	**21,909**	**12,970**	**5,855**	**6,459**	**7,825**	**3,350**	**22,083**	**198,669**	**100%**

Source: MassGIS 1999 Land Use datalayer.

B. Land Use Changes and Trends

Over a fifteen-year period from 1985 to 1999 a significant change in land uses occurred in the watershed. Forestland, cropland and pastureland categories all lost significant acreage while residential, commercial, and industrial land uses, wetlands, water, and abandoned open land increased. In that time period, over 5,200 acres of forest and 1,044 of agricultural land have been lost. (See Table IV-4)

The land use data shows that since 1985 developed acreage in the watershed increased by a total of 4,580 acres. Residential uses account for 3,700 acres. Most new residential uses involve construction of single-family homes on lots greater than ½ acre, located along the roads on the edge of large expanses of forested land. These frontage lots are a type of residential development that does not require Planning Board approval, unlike the subdivision of land. Under The Subdivision Control Act, MGL Chapter 41 Section 81K, land may legally be divided through an Approval-Not-Required (ANR) Plan.

An ANR plan may create new lot if they meet the minimum lot size and frontage requirements of the municipal zoning bylaws. ANR endorsements can be applied for if every lot within the divided tract, at the time it is divided, has existing roadway frontage as required by the zoning bylaw. Not only must new lots meet the minimum frontage requirements, they must front on one of the three types of public ways, and must receive the Planning Board's determination that the vital access to such lots is practical access, that the way is adequate, and that the access from the way to the buildable portion of the lot is adequate. In general, if the Developer meets these requirements, then the project can move forward.

Table IV-4: Millers River Watershed Land Use Acreage and Land Use Changes

Land Use Category	1985 Acres	% Land Area 1985	1999 Acres	% Land Area 1999	Land Use Change 1985 - 1999	% Change
1 Cropland	3,628	1.8	3,271	1.7	(357)	(0.18)
2 Pasture	3,448	1.7	2,760	1.4	(687)	(0.35)
3 Forestland	159,822	80.5	154,615	77.8	(5,208)	(2.62)
4 Wetland	5,583	2.8	6,052	3.0	468	0.24
5 Mining	799	0.4	1,191	0.6	393	0.20
6 Open Land	2,650	1.3	3,698	1.9	1,048	0.53
7 Participation Recreation	833	0.4	935	0.47	101	0.05
8 Spectator Recreation	19	0.01	19	0.01	0	0.00
9 Water Based Recreation	39	0.02	39	0.02	0	0.00
10 Residential Multifamily	131	0.07	182	0.09	50	0.03
11 Residential < 1/4 acre lot	1,212	0.6	1,237	0.62	25	0.01
12 Residential 1/4 - 1/2 acre lot	3,671	1.9	4,025	2.03	355	0.18
13 Residential > 1/2 acre lot	7,102	3.6	10,372	5.22	3,270	1.65
15 Commercial	621	0.3	749	0.38	128	0.06
16 Industrial	711	0.4	881	0.44	170	0.09
17 Urban Open	1,315	0.66	1,366	0.69	52	0.03
18 Transportation	1,221	0.61	1,257	0.63	36	0.02
19 Waste Disposal	470	0.2	457	0.23	(13)	(0.01)
20 Water (Freshwater)	5,182	2.6	5,316	2.68	134	0.07
21 Woody Perennial	214	0.11	248	0.12	34	0.02
Total Acres	**198,669**	**100%**	**198,669**	**100%**		

Source: Massachusetts Geographic Information Systems

Table IV-5: 1985 Land Uses by Subwatershed

Land Use Category	1 North Branch Millers River	2 Upper Millers River	3 Otter River	4 Middle Millers River	5 Tarbell Brook	6 Scott/Priest Brook	7 Lawrence Brook	8 Tully River	9 Lake Rohunta	10 West Brook	11 Gales Brook	12 Moss Brook	13 Whetstone Brook	14 Lower Millers River	Total Acres	% of Total Land Area
1 Cropland	7	29	834	1,145	80	27	171	677	129	283	52	53		140	3,628	1.8%
2 Pasture		149	714	886	35	68	231	332	217	168	226	118	1	302	3,448	1.7%
3 Forestland	1,044	13,702	28,057	30,420	3,193	5,728	8,018	18,734	10,446	4,950	5,654	7,147	3,236	19,493	159,822	80.4%
4 Wetland		931	1,289	800	170	277	478	436	438	144	141	170	38	272	5,583	2.8%
5 Mining		59	470	150	5	3	18	21	38			3	10	21	799	0.4%
6 Open Land	24	255	773	578	11	118	117	143	62	52	21	19	38	439	2,650	1.3%
7 Participation Recreation		43	257	305	2	2	4	5	149	8	20	14		26	833	0.4%
8 Spectator Recreation			19												19	0.0%
9 Water Based Recreation		2	14	15		2		0	1			3			39	0.0%
10 Residential Multifamily			39	81	7			3						1	131	0.1%
11 Residential < 1/4 acre lot			780	305	32			17		0				78	1,212	0.6%
12 Residential 1/4 - 1/2 acre lot		245	1,290	1,639	44			191	77	18	4	42		121	3,671	1.8%
13 Residential > 1/2 acre lot	108	692	1,848	1,735	178	56	158	586	621	113	201	163	24	618	7,102	3.6%
15 Commercial		17	246	287	11		3	1	4	25	4			23	621	0.3%
16 Industrial	2	1	344	251	30			20	6		7			50	711	0.4%
17 Urban Open	4	111	491	410	3		13	59	73	41	4	13		92	1,315	0.7%
18 Transportation		2	670	490	9				17					34	1,221	0.6%
19 Waste Disposal		31	196	100			3	45	15				4	76	470	0.2%
20 Water	189	1,107	1,075	981	2	0	4	635	671	17	122	78		299	5,182	2.6%
21 Woody Perennial		6	47	114				4	5	36	3				214	0.1%
Total Acres	**1,378**	**17,381**	**39,453**	**40,692**	**3,813**	**6,282**	**9,218**	**21,909**	**12,970**	**5,855**	**6,459**	**7,825**	**3,350**	**22,083**	**198,669**	**100%**

Table IV-6: Changes in Millers River Watershed Land Use by Subwatershed 1985 – 1999

Land Use Category	1 North Branch Millers River	2 Upper Millers River	3 Otter River	4 Middle Millers River	5 Tarbell Brook	6 Scott/Priest Brook	7 Lawrence Brook	8 Tully River	9 Lake Rohunta	10 West Brook	11 Gales Brook	12 Moss Brook	13 Whetstone Brook	14 Lower Millers River	Total Acres
1 Cropland	-	8.4	(166.7)	(81.0)	(4.7)	9.4	(12.2)	(77.1)	12.4	(24.0)	(2.7)	(4.4)	-	(14.5)	(357.2)
2 Pasture	2.7	(38.2)	(138.4)	(140.2)	(19.2)	(12.2)	(72.6)	(84.1)	(39.6)	(59.9)	(37.8)	(5.4)	(0.9)	(41.6)	(687.4)
3 Forestland	(45.7)	(381.8)	(2023.9)	(1106.3)	(211.9)	(101.0)	(72.2)	(428.2)	(307.0)	(143.0)	(71.5)	(94.0)	(20.6)	(200.8)	(5208.0)
4 Wetland	-	(42.8)	66.8	83.7	9.6	45.1	36.8	168.8	5.0	(56.6)	52.5	53.3	19.6	26.6	468.2
5 Mining	-	50.6	341.4	28.9	9.1	-	(7.7)	(6.9)	(14.1)	-	4.8	(3.4)	(1.2)	(8.6)	392.8
6 Open Land	0.7	131.2	342.1	123.7	36.1	(12.4)	29.0	183.0	75.7	39.5	44.8	25.5	3.1	26.1	1048.1
7 Participation Recreation	-	3.5	62.6	37.0	0.6	-	-	-	7.4	(7.8)	1.5	-	-	(3.3)	101.5
8 Spectator Recreation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 Water Based Recreation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 Residential Multifamily	-	-	36.7	-	-	-	-	1.7	-	-	-	-	-	11.8	50.2
11 Residential < 1/4 acre lot	-	-	2.8	22.4	-	-	-	-	-	-	-	-	-	-	25.2
12 Residential 1/4-1/2 acre lot	-	-	210.8	100.4	-	-	-	23.1	10.1	10.2	-	-	-	-	354.6
13 Residential > 1/2 acre lot	46.7	334.0	1022.2	779.4	139.2	69.2	69.8	206.4	226.2	161.4	39.5	33.2	-	143.1	3270.2
15 Commercial	-	15.1	70.9	27.3	2.6	-	-	-	-	11.5	-	-	-	0.6	128.0
16 Industrial	-	-	99.1	47.4	-	-	13.5	1.8	0.9	-	-	-	-	7.5	170.2
17 Urban Open	(4.4)	(80.8)	30.2	29.8	21.3	1.2	12.8	21.8	15.8	(18.7)	(2.6)	(4.7)	-	29.8	51.5
18 Transportation	-	0.6	6.7	17.7	4.0	-	-	-	-	-	-	-	-	7.1	36.1
19 Waste Disposal	-	(5.1)	16.4	(17.4)	13.5	-	1.9	(33.8)	(2.8)	-	-	-	-	14.7	(12.5)
20 Water	-	-	15.4	31.7	-	0.7	0.9	15.1	3.1	95.5	(28.4)	-	-	-	134.1
21 Woody Perennial	-	5.2	4.8	15.6	-	-	-	8.4	6.9	(8.1)	-	-	-	1.5	34.3
Total Acres	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

a) Population Changes

The uplands of the headwaters of the Millers River Watershed are experiencing significant growth pressure. Since 1980, the population of watershed communities has increased from 76,118 to 91,986 (according to the 2000 U.S. Census), an increase of 15,868 residents or twenty percent (20%). The growth pressure was greatest in the watershed communities located in Worcester County, with a total of 13,330 new residents locating in these communities (84% of the total growth). Watershed communities located in Franklin County increased by a total of 2,538 new residents (16% of the total growth. The five communities with the greatest population increases since 1980 are Gardner (2,870), Winchendon (2,592), Hubbardston (2,112), Westminster (1,768), and Ashburnham (1,471). In raw numbers, Gardner was the town that grew the most, adding 2,225 new people between 1980 and 1990 and another 645 since 1990. Winchendon and Hubbardston followed closely, each adding over two thousand new residents in the twenty-year period.

Towns that grew the least were Petersham, Templeton, Athol, Erving and Warwick. The population of Athol actually decreased by 152 since 1990. One factor contributing to the slower growth may be the distance to major employment centers such as Greenfield, Fitchburg, Leominster, and points east. The populations, growth rates, and densities per mile of municipalities in the Watershed are shown in Table IV-7 by planning area.

Table IV-7: Populations of Municipalities included in the Millers River Watershed

	1980	1990	Change	Percent Change '80 – '90	2000	Change	Percent Change '90 – '00	Pop Density/ Sq. Mi.
Montachusett Region								
Ashburnham	4,075	5,433	1,358	33%	5,546	113	2%	143
Athol	10,634	11,451	817	8%	11,299	-152	-1%	347
Gardner	17,900	20,125	2,225	12%	20,770	645	3%	936
Hubbardston	1,797	2,797	1,000	56%	3,909	1,112	40%	95
Petersham	1,024	1,131	107	10%	1,180	49	4%	22
Phillipston	953	1,485	532	56%	1,621	136	9%	67
Royalston	955	1,147	192	20%	1,254	107	9%	30
Templeton	6,070	6,438	368	6%	6,799	361	6%	212
Westminster	5,139	6,191	1,052	20%	6,907	716	12%	195
Winchendon	7,019	8,805	1,786	25%	9,611	806	9%	222
Total	**55,566**	**65,003**	**9,437**	**17%**	**68,896**	**3,893**	**6%**	**184**
Franklin County								
Erving	1,326	1,372	46	3%	1,467	95	7%	102
Montague	8,011	8,316	305	4%	8,489	173	2%	267
New Salem	688	802	114	17%	929	127	16%	16
Northfield	2,386	2,838	452	19%	2,951	113	4%	83
Orange	6,844	7,321	468	7%	7,518	206	3%	209
Warwick	603	740	137	23%	750	10	1%	20
Wendell	694	899	205	30%	986	87	10%	31
Total	**20,552**	**22,279**	**1,727**	**8%**	**23,090**	**811**	**4%**	**94**
Watershed Total	**76,118**	**87,282**	**11,164**	**15%**	**91,986**	**4,704**	**5%**	**149**

Source: US Census, 1990 and 2000

The Worcester County communities grew rapidly from 1980 to 1990, adding a total of 9,437 new residents (84.5% of the regional population increase). By contrast, the towns in Franklin County grew moderately during that time period, due in part to the rural nature of the communities and the very hilly forested terrain in many of them.

Although the overall growth rate reached its greatest intensity during the 1980s, the watershed communities still grew by 4,704 new residents, a rate of five percent (5%) from 1990 to 2000. The Worcester County communities still absorbed most of the population increase during the 1990s at 83%. Notably, Hubbardston is experiencing a relatively steady long-term growth trend. Its population more than doubled between 1980 (1,797) and 2000 (3,909), and grew by forty percent (40%) between 1980 and 2000.

Population growth in the region can be mainly attributed to immigration from the Boston metro area during the State's economic boom years. Housing development and in-migration were driven in large part by the escalating real estate prices of the greater Boston area. As prices rose, Northern Worcester County became an affordable alternative.

During the 1980's the region experienced a housing construction boom. A look at residential building permit data for the last decade indicates the pattern and pace of growth in the watershed. Many of these permits were part of large subdivisions of open land.

Table IV-8: Ten-Year Pattern of Residential Building Permits

Town	End Year of Building Permit Period	Building Permits 1990 - 1998 Or 2000	Annualized Average Building Permits*
Ashburnham	1998	277	34.6
Athol	1998	164	20.5
Erving	2000	37	3.7
Gardner	1998	432	54.0
Hubbardston	2000	415	41.5
Orange	2000	232	23.2
Petersham	2000	52	5.2
Phillipston	1998	683	85.4
Royalston	2000	55	5.0
Templeton	2000	315	31.5
Warwick	2000	36	3.6
Wendell	2000	45	4.5
Westminster	2000	452	45.2
Winchendon	1998	438	54.8
Total		**3,633**	**413**

Sources: Worcester County - Planning boards and Building Inspectors for each community, in conjunction with the EOEA sponsored Buildout Analysis. Franklin County - 1990-1994 from the U.S. Bureau of the Census- Current Construction Reports, and 1994-2000 from the U.S. Census Bureau - Building Permits Survey.

*For some communities building permits were collected for the years 1990 through 1998, for others, through 2000.

C. Protected Open Space

One of the best ways to control and prevent water pollution is to protect the land surrounding the water resource. Additional advantages include the protection of natural habitat for wildlife and the preservation of our natural heritage for future generations. The Millers River Watershed has a substantial amount of land that has already been protected, according to records on file at MassGIS current to August of 2000. Of the 198,669 acres in the watershed, 49,647 acres are protected open space, representing 25% of the entire watershed. Protected Opens Space refers to lands that are protected "in perpetuity" and includes state forests and parks, lands managed by local land trusts, lands with conservation or agricultural restrictions. The Commonwealth of Massachusetts owns more than two-thirds of the protected open space, at 33,747 acres (68%). State forests and wildlife management areas account for most of this land. Table IV-9 shows the amount of protected open space by subwatershed and jurisdiction. These protected lands are shown on the Water and Environmental Resources Map in Chapter II.

Table IV-9: Land in Millers River Watershed Permanently Protected from Development

Subwatershed	Unspecified	State	Private	Non-Profit	Municipal	Federal	Total Acres
2 Upper Millers River		1,621	329	4	353		2,307
3 Otter River		1,750		107	2,590	1,326	5,772
4 Middle Millers River		3,062	22	192	2,411	1,662	7,348
5 Tarbell Brook				85	14	44	142
6 Scott/Priest Brook		2,630				582	3,211
7 Lawrence Brook		1,954		119			2,073
8 Tully River		3,696	518	461	74	1,401	6,150
9 Lake Rohunta		1,433		804	6		2,243
10 West Brook		367	26	0			394
11 Gales Brook		1,599	21	721	49		2,390
12 Moss Brook	22	4,876			123		5,021
13 Whetstone Brook		1,271		1,081			2,352
14 Lower Millers River		9,489	205	279	272		10,244
Total Protected Open Space	**22**	**33,747**	**1,122**	**3,851**	**5,891**	**5,014**	**49,647**

Source: As reported to the MassGIS data center. From the MassGIS Open Space datalayer, August 2000.

In addition to protected open space, the watershed has 727 acres of land in municipal ownership. These lands are generally used for schools, cemeteries, municipal buildings, parks, playgrounds, and Departments of Public Works facilities for highway management and water treatment. In general, these are lands that are considered to have limited protection from development in that they could be sold off to other uses, but the likelihood of that is slight. Table IV-10 lists the lands with limited protection from development in the watershed.

Table IV-10: Land with Limited Protection from Development

Subwatershed	Owner	Total Acres
Upper Millers River	Ashburnham Municipal Property	75.3
	Winchendon Property	0.2
Otter River	Narragansett Regional School District	51.7
	Templeton Schools	16.1
	Winchendon Property	2.2
Middle Millers River	B&M RR	106.1
	Mahar Regional School District	5.7
	Athol Schools	37.4
	Orange Municipal Properties	109.3
	Phillipston Property	38.6
	Winchendon Schools	68.6
Tarbell Brook	Winchendon Schools	4.5
Tully River	Orange Municipal Properties	23.6
	Warwick Property	10.3
	Westford – Gale Brook School	2.5
Lake Rohunta	Athol Schools	47.5
West Brook	Orange – Jones Cemetery	15.0
	Westford – North Orange Cemetery	1.4
Lower Millers River	Wendell Municipal Properties	110.9
Total Acres		**727.0**

Source: As reported to the MassGIS data center. From the MassGIS Open Space datalayer, August 2000.

Under the Massachusetts General Tax Laws, Chapters 61, 61A, and 61B, landowners who are willing to keep agricultural, forested, or recreational lands open are given a tax abatement. These lands are not considered protected, however, in that the landowner can opt to remove his lands from the program and develop them. Should the owner choose to transfer the land, the town is given the right of first refusal, unless the transfer is to a family member.

A total of 8,870 acres of land is listed under the Chapter 61 program. Of these acres, 3,509 acres is under the forestry program. Lands in this program are listed for ten-year periods, during which time the land is generally used for forestry purposes. Logging practices are subject to State law governing cutting practices and large-scale operations must conform to laws and regulations governing erosion control. Another 2,957 acres are listed in the Agricultural Program (Ch 61 A). Lands listed in this program must be updated annually. Agricultural practices may be either active or passive, and can include the buildings and roads required for farming the land. Finally, under Chapter 61 B, there are 2,295 acres used for private camping grounds, sportsmen's clubs, and recreational facilities. Lands listed in this program must also be updated annually. Table IV-11 lists the acreage of lands in each program, by subwatershed and town, current to August of 2000. The information should be tracked and updated annually, since change is fairly constant in this program, and the lands could either become protected open space, recreational facilities, residential subdivisions, or industrial complexes.

Recently, the Executive Office of Environmental Affairs issued a Request for Responses for a Regional Open Space Plan for the Millers River Watershed. Upon completion of that document, the information in each of these tables will be updated and an action plan for regional priorities will be developed that conforms to both the vision of each local community and the standards outlined by the Division of conservation Services. Completion of that document is slated for the summer of 2004.

Table IV-11: Land in the Millers River Watershed Under Temporary Protection Through Chapter 61

Subwatershed	Town	Forestry Acres	Agriculture Acres	Recreation Acres	Unspecified	Total Acres
Otter River	Gardner	68	344	370		782
	Hubbardston			67		67
	Templeton		158	111		268
	Westminster			257		257
Middle Millers River	Athol			144		144
	Orange	492	835	121		1,448
Tully River	Athol			128		128
	Orange	487	574	274		1,335
Lake Rohunta	Athol			317		317
	Petersham			83		83
West Brook	Orange	939	625	70		1,634
Gales Brook	Orange	400	1			401
Moss Brook	Orange	9				9
Whetstone Brook	Orange	31	28			59
	Wendell	113		207		320
Lower Millers River	Erving	118				118
	Northfield	12				12
	Wendell	840	391	145	109	1,486
Total Acres		**3,509**	**2,957**	**2,295**	**109**	**8,870**

Source: As reported to the MassGIS data center. From the MassGIS Open Space datalayer.
Note: Updated information from the Assessor's Office of the Town of Athol reveals a total of 1,796 acres under Forest Protection, 647 acres under Agricultural Protection, and 649 acres under Recreation Protection as of the year 2001.

D. Development Potential (Build-out Analysis Results)

The Executive Office of Environmental Affairs (EOEA) sponsored the creation of buildout analyses for all 351 towns and cities within the Commonwealth of Massachusetts in support of the Community Preservation Act. At the local level, EOEA believes that Community Preservation is about maintaining quality of life in our municipalities by empowering cities and towns to preserve what is important to their individual character. This community preservation effort is also about recognizing the potential negative effects of sprawl development, and the potential for disproportionate growth in certain regions.

Buildout analyses illustrate the maximum development permitted as-of-right by the local zoning bylaws currently in place. The buildout provides an estimate of the total number of houses and commercial/industrial square footage that could result if every piece of unprotected, buildable land is developed, if no more land is permanently protected within a community, and if zoning remains unchanged. In addition, the buildout can provide insight to the potential burdens on community infrastructure. That is, the analyses used a projected growth rate based upon past growth trends, population forecasts and economic forecasts, communities can anticipate the length of time needed to reach buildout and to reach certain growth thresholds such as when additional schools, water supplies and sewer systems will be needed. This information can provide a framework for planning future community budgets as well.

EOEA contracted with Regional Planning Agencies and Commissions across Massachusetts to develop buildouts for their respective communities. The methodology used defines buildable land as undeveloped, unprotected, upland that does not include transmission lines or land within 100 feet of a stream or river. The analysis reflects a community's zoning bylaws and regulations, especially concerning the way they treat resource areas such as wetlands and floodplains. For example, if wetland areas can be included in gross building lot area minimums, then wetlands are not considered an absolute constraint to development. Yet wetlands may be considered partial constraints if they restrict the density or type of development in a given area. For exam-

ple, there may be a 25% limit on all impervious surfaces on parcels located within a certain distance of a wetland. The methodology takes this into account.

The buildout analyses by Montachusett Regional Planning Commission and Franklin Regional Council of Governments revealed a total of 169,964 acres of residentially zoned developable land under current land use controls. Given existing zoning and use controls for commercial and industrial uses the region has potential for 142,889,365 square feet of floor area. If the region builds out under current zoning, planners can expect to see 96,237 new housing units. The population can be expected to increase by 255,849, nearly quadrupling the current population. If current family-size trends are extended, the student population would increase by 49,992, nearly tripling the current student body. Total water demand would increase by 600 percent. Note that the current water demand estimate is based upon a formula specified by the buildout methodology. Actual water demand may be very different as discussed in the infrastructure section on water supplies. Currently, the watershed has 1,316 miles of roads, most of which are under local jurisdiction. At buildout the total road miles would more than double, increasing by 1,841 miles to a total of 3,157 miles. Most of these roads would be created to accommodate new housing and subdivisions, placing them under the jurisdiction of the local communities. Table IV-12 summarizes the potential impact for the watershed. Buildout analyses for individual communities are available through MassGIS, Montachusett Regional Planning Commission, and Franklin Regional Council of Governments.

As of this writing current statistics on tons per year of municipal solid waste generated were unavailable. Following the buildout methodology, the region could anticipate 117,440 additional tons per year of solid waste. To grasp the magnitude of total solid waste management required at buildout, it is recommended that the current rate of solid waste disposal be calculated, both by community and per capita. These rates should then be compared with the buildout formula and adjustments should be made to the estimated quantity of future solid waste.

Though these figures seem alarming, they represent an opportunity for the communities of the region to look at their vision for the future and make adjustments to their current zoning practices. New growth management strategies such as land acquisitions for preservation and open space residential design can help to reduce the potential burden to the communities and to the watershed.

Table IV-12: Buildout Analysis Summary Statistics for Millers River Watershed

Buildout Impact for the Millers River Watershed	Current	Additional	Future
Population	89,164	255,849	345,013
Size of Student Body	21,687	49,992	71,679
Households/Housing Units	34,391	96,237	130,628
Residential Developable Land Area (sq. ft.)		7,403,627,328	
Residential Developable Land Area (acres)		169,964	
Commercial/Industrial Buildable Floor Area (sq. ft.)		142,889,365	
Water Demand (gallons per day)	5,818,175	29,874,268	35,692,443
Residential Water Use (gallons/day)		*19,157,565*	
Comm./Ind. Water Use (gallons/day)		*10,716,703*	
Additional Municipal Solid Waste (tons/year)		117,440	
Non-Recycled Solid Waste (tons/year)		*93,183*	
Recyclable Solid Waste (tons/year)		*28,837*	
Road Miles	1,316	1,841	3,157

Source: Buildout Analysis by Montachusett Regional Planning Commission and Franklin Regional Council of Governments, sponsored by the Massachusetts Executive Office of Environmental Affairs, 2000-2001

E. Infrastructure

Water plays a very important role in supporting our communities. We use a lot of water every day for drinking, for disposal of our sewage, for irrigating croplands and lawns and local industries. The amount of money we, as individuals, pay for our clean drinking water depends on its supply and the amount of effort that is invested with purifying techniques. Surface water supplies often require expensive filtration plants that are monitored regularly by paid professionals. In comparison, aquifers contain water that enters the soils within a sub-watershed as precipitation and which slowly infiltrates the ground water levels. This slow infiltration process helps to purify the water at little cost to the consumer. This is one way in which watersheds, in their natural vegetated state, provide a valuable ecological service. Land naturally contributes to the hydrologic cycle by storing and releasing water. However, the manner in which we use land can hinder this ecological process by preventing water from infiltrating topsoil and by allowing contaminated water to leach into the groundwater.

Drinking water in the Millers River Watershed comes from both groundwater and surface water. The introduction of public water supplies and sewers creates the potential for water to be diverted and/or discharged into other sub or major watersheds, potentially reducing water availability near the withdrawal point and reducing water supplies. Even if water resources seem extensive enough to meet current demand, water loss through an interrupted hydrologic cycle may lead to water shortages. Often, water becomes contaminated during the consumption, use and discharge process. Though groundwater is less susceptible to contamination than surface water, it is much more expensive to clean up once it is polluted. Watershed ownership is considered the best way to ensure water quality. The communities in the watershed may want to regulate the amount of water used by incoming industries to encourage conservation.

1. Water Supplies

The surficial geology of the watershed reflects repeated glaciations, which eroded the terrain to bedrock and subsequently deposited layers of till and stratified drift. These stratified glacial deposits in stream valleys form the best aquifers in the Millers River watershed. Drift deposits with a saturated thickness of greater than 40 feet may be suitable for municipal water supplies if they yield 200 gallons per minute for extended periods. The largest area of glacial outwash was deposited in a glacial lake located in present-day Athol. Meltwater streams deposited sediments up to 200-ft thick into this lake.

MassGIS produced an aquifer datalayer mapping areas of high and medium yield. The U.S. Environmental Protection Agency has identified three Early Mesozoic sandstone basin principal aquifers in the Millers River Watershed.[37] These areas, capable of yielding more than 200 gallons per minute of ground water to wells, occur near the mouth of the Millers River in Millers Falls, along the Tully River northwest of Athol, along the Otter River and Trout Brook, and along the Millers River and Otter River through Winchendon and Templeton.

Four aquifers are known to underlie the Town of Athol. One aquifer underlies Lake Ellis, though the Athol Department of Public Works determined that it was insufficient to support the needs of the town. A second aquifer underlies the Millers River and supports the South Street Municipal Well. The South Street Well has a safe yield of 1.4 million gallons per day (mgd) and a permitted withdrawal of 1.08 mgd. It now serves as Athol's reserve supply. A third aquifer, underlying the Tully River, has a potential yield of 3.0 mgd, and now supports three wells at Athol's new Tully Wellfield. A fourth aquifer, which lies beneath the White Pond-South Athol Pond complex, may be considered as a future public groundwater resource.

The aquifer underlying the Millers River in Winchendon and Templeton has coarse-grained stratified drift deposits of sand and gravel with a saturated thickness greater than 20 feet. Recharge of the aquifer is afforded by the rural nature of the land use. At its northern extent the Town of Winchendon has sited both a wastewater treatment plant and a landfill (now capped and closed). At present, the town does not tap the aquifer.

[37] USGS Principal Aquifers of the 48 Contiguous United States 1998, http://www.nationalatlas.gov/aquifersm.html

Public Water Systems

The Massachusetts Department of Environmental Protection (DEP) monitors water withdrawals when the water supplier provides connections for at least fifteen households or a single connection for 25 or more people (310 CMR 22.00). In Millers River Watershed, over 50 companies, organizations and municipalities are permitted by DEP. Public water systems supply eleven Millers River Watershed communities- Ashburnham, Athol, Erving, Gardner, Hubbardston, Orange, Royalston, Templeton, Warwick, Westminster, and Winchendon. The water suppliers do not provide drinking water for all inhabitants in each community. Those not connected to public water distribution systems rely on private wells for their drinking water and commercial water needs[38].

Throughout the entire Millers River Basin, MRPC estimated that the eight public water systems combined withdraw approximately three million gallons per day (mgd), based on information collected from water departments in each community. In addition to the public water withdrawal, over forty private community and non-community well systems exist throughout the watershed that have a pump rate less than 70 gallons per minute. Assuming they operated at their maximum capacity, it is estimated that their average daily withdrawal exceeds an additional four million gallons per day. In total, these water supply systems may account for over seven million gallons per day of water consumption. This forecast, however, is a rough estimate and it does not include individual private household wells in the watershed.

The term 'safe yield' refers to the measure of the total capacity of a well or surface reservoir. The safe yield of a well is equal to the amount of water that could be pumped on a daily basis, during an extended drought (180 days) without reducing the capacity of the well. The safe yield does not take into account the impact of draw down on local wetlands or the risk of contamination within the recharge area.

The MassGIS maintains a Public Water Supply datalayer that contains the locations of public community surface and groundwater supply sources and public non-community supply sources as defined in 310 CMR 22.00. Public water supply systems are included in this datalayer based primarily on information in the DEP's Water Quality Testing System (WQTS) database. The datalayer also contains the locations of proposed wells that have a defined DEP approved wellhead protection area (Zone II's).

Public Water Systems provide piped water for human consumption to at least 15 service connections or regularly serve an average of at least 25 individuals daily at least 60 days of the year. A public water system is either a "community water system" or a "non-community water system." Community water systems serve connections used by year-round residents. Non-community water systems are classified as either Transient or Non-Transient. A transient non-community water system (TNC) serves water to 25 different persons at least 60 days of the year. Examples include restaurants, motels, campgrounds, parks, golf courses, ski areas and community centers. A non-transient non-community water system (NTNC) serves at least 25 of the same persons or more approximately four or more days per week, more than six months or 180 days per year, such as a workplace providing water to it's employees.

In the Millers River Watershed, there are three classes of public water supplies: those that are actively available yet have no protection plans, those that are available for emergency use and have no protection plan, and those that have a protection plan *(See Tables IV-13, IV-14, and IV-15).*

A total of ten community groundwater supplies are listed in the MassGISdatalayer. The water supplies are located in the towns of Athol, Erving, Hubbardston, Gardner, Orange, Royalston, and Templeton. Three of these are private water supplies: the Weatherheads well in Erving, the MCI Warwick Well, and the Silverleaf Hollow Condominium Well in Hubbardston. The remaining six supplies feed wells run by the town water departments of Athol (4), Erving (1), Orange (2), Templeton (4), Royalston (1), and Winchendon (2).

Numerous transient non-community wells throughout the watershed serve campgrounds and outdoor clubs, restaurants, hotels, local businesses and State Forest facilities. Most of these wells are unprotected.

[38] MassGIS - Public Water Supply (PWS) datalayer (coverage and layer are named **PWS_DEP**), based on the DEP's Water Quality Testing System (WQTS) database.

Eight non-transient non-community supplies feed wells that serve local school systems and major employers in the watershed. Three of these lack wellhead protection: Erving Well #3 serving the Erving Paper Mills, Wendell Wells #1, #2, #3 and #4 serving the Lake Grove School, and Erving Well #1 serving the Erving Elementary School.

Finally, the datalayer lists five community surface water supplies, three of which did not have protection plans at the time the information was published. These three are located in Gardner, Athol, and Orange. The Gardner supply is from three sources: Cowie Pond, Crystal Lake Reservoir, and Perley Brook Reservoir. The Athol supply is from Lake Ellis and Thousand Acre Reservoir. The Orange supply is from Crystal Spring. Though these supplies are listed in the datalayer as having no protection plan, several of them are listed as outstanding resource waters as listed in Chapter II, Section 5.

Table IV-13: Actively Available Water Supplies with No Protection Plan

Town	Subwatershed	TYPE	Status[1]	Name of Supplier	Name of Source	Pump Rate (GPM)
Athol	Lake Rohunta	TNC	A	Morgan Memorial Fresh Air Camp	Well # 1 "Clark Well"	gpm < 70
	Tully River	CGWS	A	Athol DPW, Water Division	Well #1 Tully Wellfield	> 70 gpm
					Well #2 Tully Wellfield	> 70 gpm
					Well #3 Tully Wellfield	> 70 gpm
Erving	Lower Millers River	CGWS	A	Weatherheads	Well # 1	gpm < 70
		NTNC	I	Erving Paper Mills	Well # 3	gpm < 70
		TNC	A	Box Car Restaurant	Well # 1	gpm < 70
				Dem Erving State Forest	Well # 1 (Headquarters Well)	gpm < 70
				Freight House Antiques	Well # 1	gpm < 70
				French King Motor Inn	Well # 1	gpm < 70
	Moss Brook	TNC	A	Dem Erving State Forest	Well # 2 (Laurel Lake Well)	gpm < 70
Gardner	Otter River	CSWS	A	Gardner Water Department	Cowie Pond	gpm < 70
					Crystal Lake Reservoir	gpm < 70
					Perley Brook Reservoir	gpm < 70
New Salem	Lake Rohunta	TNC	A	Morgan Memorial Fresh Air Camp	Well # 2 "Cooke Well"	gpm < 70
					Well # 3 "66"	gpm < 70
Orange	Middle Millers River	TNC	A	Kingsing Restaurant	Well # 1	gpm < 70
			I	Knights Of Columbus	Well # 1	gpm < 70
	Tully River	TNC	A	Stonewall Farm Country Store	Well # 1	gpm < 70
Petersham	Lake Rohunta	TNC	A	Petersham Country Club	Well # 1	gpm < 70
Phillipston	Middle Millers River	TNC	A	Fox Run Restaurant	Well # 1	gpm < 70
				King Phillip Restaurant	Well # 1	gpm < 70
				Lamb City Campground	Well # 1	gpm < 70
Royalston	Tully River	TNC	A	Lake Tully Campground	Well # 1	gpm < 70
Warwick	Gales Brook	CGWS	I	MCI Warwick	Well # 1	gpm < 70
	Moss Brook	TNC	A	Wagon Wheel Camping Area	Well # 1	gpm < 70
Wendell	Lower Millers River	NTNC	A	Lake Grove School	Well # 1	gpm < 70
					Well # 2	gpm < 70
					Well # 3	gpm < 70
			I	Lake Grove School	Well # 4	gpm < 70
		TNC	A	Dem Wendell State Forest	Headquarters Bldg Well	gpm < 70
					Picnic Area Spring	gpm < 70

Source: MassGIS Public Water Supplies datalayer.
[1]A = Active, I = Inactive

Table IV-14: Water Supplies Available for Emergency Use with No Water Supply Protection Plan

Town	Subwatershed	TYPE	Status[1]	Name of Supplier	Name of Source	Gallons/ Minute
Athol	Middle Millers River	CSWS	A	Athol DPW, Water Division	Lake Ellis	gpm < 70
					Thousand Acres Reservoir	gpm < 70
Orange	Middle Millers River	CSWS	I	Orange Water Department	Crystal Spring	> 70 gpm
Winchendon	Upper Millers River	CGWS	I	Winchendon Water Department	Well # 1	> 70 gpm
					Well # 2	> 70 gpm
Erving	Lower Millers River	NTNC	I	Erving Elementary School - Inactive.	Well # 1	gpm < 70
		TNC	I	The Tavern In Erving	Well # 1	gpm < 70
Orange	Tully River	TNC	I	Jolly Brook Inn	Well # 1	gpm < 70
Petersham	Lake Rohunta	TNC	I	Petersham Curling Club	Well # 1	gpm < 70
Phillipston	Middle Millers River	TNC	I	Woodland Campground	Well # 1	gpm < 70
Royalston	Middle Millers River	TNC	I	Camp Caravan	Well # 1	gpm < 70
Winchendon	Upper Millers River	TNC	I	Pops Hot Dog Stand	Well # 1	gpm < 70

Source: MassGIS Public Water Supplies datalayer.
[1]A = Active, I = Inactive

Table IV-15: Water Supplies with Protection Plan in Place

Town	Subwatershed	TYPE	Status[1]	Name of Supplier	Name of Source[2]	Total
Ashburnham	Upper Millers River	CSWS	A	Ashburnham Water Department	Upper Naukeag Lake	gpm < 70
				Winchendon Water Department	Upper Naukeag Lake	gpm < 70
Athol	Middle Millers River	CGWS	A	Athol DPW, Water Division	South Street GPW #1	> 70 gpm
		CSWS	A	Athol DPW, Water Division	Newton Reservoir	gpm < 70
					Phillipston Reservoir	gpm < 70
Erving	Lower Millers River	CGWS	A	Erving Water Department	Well # 1	> 70 gpm
		NTNC	A	Erving Paper Mills	Well # 1	gpm < 70
					Well # 2	gpm < 70
Hubbardston	Otter River	CGWS	A	Silverleaf Hollow Condo	Well # 1	gpm < 70
Orange	Middle Millers River	CGWS	A	Orange Water Department	GP Well # 1 Crystal Spring	> 70 gpm
					GP Well # 2 Magee Meadow	> 70 gpm
	Tully River	NTNC	A	Gale Brook School	Well # 1	gpm < 70
Royalston	Lawrence Brook	NTNC	A	Royalston Community School	Well #1	gpm < 70
	Middle Millers River	CGWS	A	South Royalston Improvement Corp.	Blossom Street Rock Well	gpm < 70
	Tully River	NTNC	A	Village School & Raymond School	Well #1	gpm < 70
Templeton	Otter River	CGWS	A	Templeton Water Department	GP #1 Birch Hill Well	> 70 gpm
					GP #2 Birch Hill Well	> 70 gpm
					Otter River GPW	> 70 gpm
					Sawyer Street GPW	> 70 gpm
Warwick	Gales Brook	NTNC	I	Warwick Center School	Well # 1	gpm < 70
Winchendon	Upper Millers River	TNC	I	Camp Riverwood	Well # 1	gpm < 70

Source: MassGIS Public Water Supplies datalayer.
[1]A = Active, I = Inactive
[2] GPW = Gravel Packed Well

Current Services and Planned Repairs and Upgrades

Ashburnham - Dams at lakes Wampanoag and Winnekeag provide a power source for the Fitchburg paper industry. The town supplies drinking water to its residents and to residents of Winchendon through the spring fed Upper Naukeag Lake, a 240-acre reservoir in North Ashburnham. A safe yield analysis determined that the reservoir has a safe yield of 1.7 million gallons per day, on average. At present, Ashburnham draws and average of 250,000 gallons per day, and Winchendon draws and average of 700,000 gallons per day. The Town's Open Space and Recreation Plan from 1989 stated there is no evidence of an existing aquifer sufficient for de-

velopment of municipal wells. This led to the establishment of a water supply protection district around the lake. The district parameters specify permitted uses and establish lot size guidelines. In 1993, MRPC published a Watershed Resource Protection Plan for the water supply that included a risk assessment, recommendations for sanitary surveys of lake front properties and acquisition of large lake front parcels, and a management and operations plan. Currently, Ashburnham and Winchendon are constructing a new $6 million filtration plant to expand the safe yield of Upper Lake Naukeag.

Athol – The Department of Public Works provides drinking water to businesses and residents in the central core of Athol. Outlying areas are served by private, individual wells. Historically, the Town obtained its water from the Newtown and Phillipston Reservoirs located in the hills on the eastern edge of town. Thousand-Acre Reservoir was once connected to the Newton Reservoir system, but it has been inactive for fifty years because of the unappealing color of the water. The gravity fed water distribution system included a water treatment facility constructed on Hillside Terrace in 1938. Raw water was treated with lime, alum, and sodium hypochlorite in a dual-chamber mixing basin. Treated water then flowed into two sedimentation basins, and three rapid sand filters, and was finally pumped into storage tanks. The surface supply system suffered from severe depletion during the dry summer months.

On May 1st, 2000, the Tully Well Field Treatment and Distribution System went on-line. This new facility replaces the South Street Municipal Well as Athol's primary source, significantly increasing the Town's capacity and abolishing the need to invest four million dollars ($4,000,000) in updating Athol's antiquated filter plant. The Tully Wells have the potential to expand available water by more than 2.0 mgd, though any higher water withdrawals will be regulated by DEP to coincide with historic use figures and actual population increases. These wells may have eliminated Athol's need for the Newton and Phillipston Reservoirs, which previously served as reserve supplies. The Athol Department of Public Works recently ceded management of the Newton Reservoir property to the Conservation Commission.

Erving – All areas of Town, outside of Ervingside, are served with non-community public and private wells or springs. Erving Well #1, installed along the Millers River in 1983, serves the one community water supply located in Ervingside. The Erving Water Department contracted with the engineering firm Tighe & Bond to prepare the Conceptual Zone II Delineation for Well #1 in July of 1999. The recharge area for the well occupies an estimated 0.7 square miles in Erving between Poplar Mountain and East Mineral Hill. The area is currently zoned for commercial and residential uses. Routes 63 and 2, and the railroad tracks are located within the Zone II recharge area as well. This aquifer's Zone III is east of the recharge area for Well #1 in the till and bedrock along the northwestern slope of Poplar Mountain. Land uses within the delineated Zone II area will be assessed their potential to contribute contaminants to the ground water, the aquifer, and the well. The Town is also conducting water tests and developing revisions to its bylaws to protect the water supply. [39]

The intent of the proposed Groundwater Protection District Bylaw is to regulate land uses for density, impervious cover, and groundwater recharge to protect the aquifer from contamination. The delineated Zone II recharge area for Erving Well #1 represents the boundaries of the Groundwater Protection District.

Recent water quality testing for Erving's Well #1 between 1995 and 1998 has shown that sodium was the only substance that exceeded Massachusetts Drinking Water Standards Guidelines for Chemicals in Massachusetts Drinking Waters. In April of 1997, 1998, and in May of 1998, levels of sodium were found to be thirty-nine (39) milligrams per liter (mg/l), seventy (70) mg/l, and sixty-four (64) mg/l. The Office of Research Standards and Guidelines criterion for sodium is below twenty (20) mg/l. The 1999 Tighe & Bond study notes that the source of the sodium could be the Town's addition of sodium hydroxide to the well to buffer the low pH levels in the water. However, according to Tighe & Bond, a more likely source is the long-term use of road salt on nearby Rte. 2.

Gardner – The primary water source in Gardner is Crystal Lake, a natural spring fed lake that once served as a recreational resort. The lake has a useful volume of 350 million gallons. Perley Brook Reservoir, built in 1958, supplements the Crystal Lake water supply. It has a useful volume of 206 million gallons[40]. A network of wa-

[39] Erving Open Space and Recreation Plan, Franklin Regional Council of Governments
[40] Gardner Open Space and Recreation Plan, 1994, The Berkshire Design Group.

ter mains supplies the developed areas and all industrially zoned parcels. The Gardner Water department holds 1,817 acres of town land, as well as 81 acres of land in Ashburnham and 102 acres in Winchendon, for the protection of the watershed. The town is making improvements to the Crystal Lake filtration plant and is developing a new well with a potential pump rate of more than 70 gpm in the Otter River/Snake Pond Area at Snake Pond, which should be operational by the summer of 2000. In addition, the City recently acquired three priority parcels along the Otter River for wellhead protection. The City plans to identify and acquire additional parcels in its Watershed Protection Districts.

Gardner shares surface and groundwater resources with its neighbors Ashburnham, Winchendon, Templeton and Hubbardston. Cross-boundary cooperation may be required to protect watersheds and aquifer recharge areas. The Greater Gardner Sustainable Growth Management Plan recommended that Gardner should enter into a multi-town agreement to examine the critical issue of water supply protection. Collaboration with Templeton is especially important, both to safeguard Gardner's new well near Snake Pond and to manage responsibly the Gardner-related land uses in Templeton such as the airport and wastewater treatment plant. Gardner's leaders have discussed the need to adopt a local wetland bylaw to supplement state wetland protection provisions.

Hubbardston – The town has no public water supplies and relies solely on private wells. In 1973 and 1974, the U.S. Department of Agriculture and the Massachusetts Water Resources Commission identified three prime potential reservoir sites in the town. Two of these sites are located on Canesto Brook, and the third is located on Mason Brook. Though these sites are outside of the Millers River Watershed, they were estimated to have the potential to supply up to 3 million gallons per day, and could potentially meet the needs of portion of the community that is in the watershed, should they ever be constructed.[41]

Orange - The Town of Orange has ample surface water and groundwater supplies. The Lake Mattawa surface water supply is used for emergency purposes only. Three aquifers in the Town support three public community gravel-packed groundwater wells. The high yield aquifer supplying Wells #1 and #2 is lies between the Millers River and Butterfield Park, west of North Pond Brook, and east of Holtshire Road. Its potential yield is fifty to two hundred gallons per minute. This aquifer has a DEP Approved Zone II Aquifer Protection Recharge Area. Two low yield aquifers supply Well # 3. One surrounds Lake Mattawa running north to the Millers River and south to New Salem. The other low yield aquifer reaches north to South Orange and east past Lake Rohunta into Athol. The DEP Approved Zone II Aquifer Protection Recharge Area for Well #3 lies mostly east of Route 122 and South of Route 2 and extends south into New Salem. [42]

Low yield aquifers also exist surrounding Moss and Orcutt Brooks in West Orange, West Brook, and the West and East Branches of the Tully River as well as Tully and Packard Ponds. Another large high yield aquifer follows the West Branch of the Tully River from the Millers River to the confluence of Fish Brook.

Well #1, the oldest well, has a safe yield of 360,000 gallons per day. Located on town-owned land off of Holtshire Road, the well is manually operated and used as a primarily as a backup water source to Wells #2 and #3 due to an historic high iron content. Well #2, located off of West River Road, south of the Millers River has a safe yield of 520,000 gallons per day. Well #3, located east of Routes 202 and 122 near the New Salem border, has a safe yield of 837,000 gallons per day.

At 685,000 gallons per day, current demand for publicly supplied drinking water is far below its capacity. At Well #2, the Water Department pumps 274,000 gallons per day (40% of the daily demand). At Well #3, the town pumps 411,000 gallons per day (60% of the daily demand). In both cases, the average daily withdrawal is less than half the safe yield of the supply.

In July of 1994, DEP granted the Orange Water Department a twenty-year permit to withdraw water. The DEP reviews the amount permitted every five years to match the withdrawal volume to the size of the population. For the first five-year period the permit allowed the Water Department to withdraw 270,000 gallons per day beyond their registered withdrawal amount of 630,000 gallons. At present, the permit allows an average daily withdrawal of 300,000 gallons beyond their registered volume, or a total of 930,000 gallons per day, until 2003.

[41] Town of Hubbardston Open space and Recreation Plan 1988 – 1992.
[42] Orange Open Space and Recreation Plan, Franklin Regional Council of Governments

Recently traces of trichloroethylene (TCE) were detected in Well #3 in the range of 2.8 ppb (parts per billion.) Although this is not a dangerous level (wells cannot be used if levels exceed 5 ppb on a quarterly basis), the presence of this chemical raises concern for potential hazards. The Massachusetts Department of Environmental Protection did an extensive survey and, according to the Orange Water Department (D. Kilhart; 2000) could not find any potential source for the contaminant.

Phillipston – The town has no public drinking water supplies. All homes have private, individual wells. Bates Reservoir, Secret Lake and Thousand-Acre Swamp once served as drinking water supplies for the Town of Athol. The medium yield aquifers in Phillipston are part of or touch an Outstanding Resource Waters area on the western edge of town around Thousand -Acre Swamp. Aquifer recharge areas include Kendall Brook, Chickering Brook, Beaver Brook and Popple Camp Brook.

Royalston – The South Royalston Improvement Corporation supplies water to 52 homes, two businesses, a church and a school. Water is pumped from a deep well adjacent to the Millers River to a 120,000-gallon concrete tank. In 1996, Royalston received a community Development Block Grant to improve its infrastructure for fire protection. The project consisted of replacement of small diameter water mains with 8-inch diameter lines, installation of 750 linear feet of water lines with hydrants on the south side of the river, installation of water meters, replacement of 20 lead service connections, and improvements to the pump station in the Village of South Royalston

Templeton – Templeton has four wells, two of which tap an aquifer which underlies the Otter River along the Templeton/Gardner border, and two of which tap an aquifer that extends south from Winchendon along the Otter River. According to a local resident one of the Maple Street wells is on the site of an early town dump. The town just completed construction of a one million gallon water tank in the Autumn of 2001. The new tank compliments the service provided by two half-million gallon tanks on South Road and Ladder Hill Terrace. It balances the pressure between the high and low-pressure zones in the town. Templeton recently received funding to dig a new well to meet the town's demands; currently they exceed their safety yield on a regular basis.

Warwick - According to MassGIS, Warwick contains five major and six minor low-yield aquifers. The major low-yield aquifers are found in soils surrounding the wetlands associated with Grace and Darling Brooks, Mountain and Kidder Brooks, Gales and Orcutt Brooks, Mill Brook and Bass Swamp, and Tully Brook and Sheomet Lake. The minor low-yield aquifers are scattered throughout the northwestern and northeastern corners of Town, within Steven's Swamp, and around the headwaters of Moss Brook. Although Warwick contains several water bodies, there are no drinking water reservoirs in Town.

Wendell - The Town of Wendell has no existing municipal water supply and therefore relies solely upon private wells for its drinking water supply. In 1994, Timothy Limbers, a graduate student at the University of Massachusetts, conducted a hydrogeological investigation for Wendell to determine potential aquifer locations and recommend protection methods. He identified Osgood Brook Wetland, a kame-aquifer system located in the headwaters of Osgood Brook, approximately one mile northeast of Wendell Center, as the most promising municipal groundwater supply for the Town. The upper limit of developable groundwater from this aquifer ranges from a conservative 170,000 gallons per day (0.17 million gallons per day) to 450,000 gallons per day (0.45 mgd)depending upon the method of calculation. The lower estimate did not account for underflow and storage within the wetland. Some chemical treatment of water from the aquifer might be required to reduce concentrations of iron and manganese to acceptable levels. Two other major sites are Wendell's two largest groundwater basins, Mormon Hollow Brook and Whetstone Brook basins. The upper limits of these stratified drift aquifers were found to be over one million gallons per day for each (1.12 and 1.29 mgd, respectively).

In addition to these aquifers, Limbers found five other areas with groundwater development potential: An area of kame deposits located in the headwaters of Mormon Hollow Brook west of Wendell Center; an area of kame-delta and kame terrace deposits along Whetstone Brook near the Orange border; an area of kame deposits along Plympton Brook or Fiske Brook near Wendell's southern border; and two areas along the northern border of Wendell which are underlain by river-terrace deposits with high yield potential.

In the early 1970s, the U.S. Department of Agriculture (USDA) conducted three surveys to identify potential reservoir sites. Calculating areas of potential open water impoundments from topographic maps, they identified numerous potential reservoir sites in Wendell. In a survey of the Millers River Watershed in 1974, they identified ten potential reservoir sites. Four of these locations are along Whetstone Brook, three are along Osgood Brook (including Bowens Pond), two along Lyons Brook (including Ruggles Pond), and one along Mormon Hollow Brook. In a survey of the Connecticut River Watershed in 1975, the USDA identified six potential and existing reservoirs in the Sawmill River sub-watershed, in the southwesterly corner of Wendell. These include upgrading existing sites on Fiske Pond and Tyler Pond and four new sites, three on Plympton Brook and its tributaries and one on Red Brook about two thousand (2,000) feet north of the Leverett town line. In a survey of the Chicopee River Watershed in 1973, the USDA identified three potential reservoir sites in the Swift River Watershed in the southeasterly corner of Wendell. Two of these are on the west branch of the Swift River and one is at the outlet of Sibley Swamp. No detailed plans were presented for these since they were on MDC land and presumably would reduce the amount of water reaching Quabbin.

The development of surface reservoirs for the purpose of increasing drinking water supplies would have at least two negative impacts on open space. First, by damming existing streams, many ecosystems and their inhabitants would be destroyed. The streams and their riparian areas would disappear, and the flow of water would be unnaturally removed from the sub-basin, which would affect groundwater recharge of local wetlands and associated plant and wildlife populations. The provision of ample drinking water supplies would also result in encouraging an increased level of population in-migration. Both of these impacts are unacceptable to Wendell residents.[43]

Westminster – Westminster has a total of 1,431 acres of water contained in 17 open water bodies. The City of Fitchburg owns 1,557 acres of land surrounding Meetinghouse Pond, and the Town of Winchendon owns 15.8 acres, for the protection of public water supplies. The town is in the process of hooking up to the Fitchburg water system and anticipates the ability to meet demand for the next twenty years. The Fitchburg public water supply at Meetinghouse Pond serves the Westminster public water system, providing water to 60% of the population. The remaining 40% obtain their water from private wells and springs. Meetinghouse Pond has a safe yield of 1.36 million gallons per day. Westminster is permitted to withdraw 100 million gallons of water per year without payment to Fitchburg. The two communities are constructing a new water filtration system, pumping station and connections to the existing supply system. Westminster owns a smaller water supply at the 14-acre Wyman pond. The site has a single well with a safe yield pumping capacity of 1 million gallons per day.

Winchendon – Winchendon relies on Upper Naukeag Lake, a spring fed surface water reservoir in Ashburnham, for its drinking water supply. A safe yield analysis determined that the reservoir has a safe yield of 1.7 million gallons per day, on average. At present, Ashburnham draws and average of 250,000 gallons per day, and Winchendon draws and average of 700,000 gallons per day. The Town's pump station was built in 1950 at the northwest corner of the lake. Water is pumped to two holding tanks, one at Murdock Hill (capacity 1,56 million gallons), and the other at Old Centre on High Street (capacity 1 million gallons). The gravity-fed distribution system serves 2,000 customers, including homes and businesses, in the town center. The distribution pipes are estimated to be between 80 and 100 years old and, in many areas, are in need of overhaul or replacement. Anticipated demand in the next decade is expected to exceed the safe yield for the Lake and the Town will need to develop alternative sources for public water. The Winchendon Department of Public Works estimated that the system served roughly 58 percent of the 9,600 residents, in 1998. The remaining 42 percent rely upon private wells for their drinking water.[44]

In 1986, the Town conducted a test well and exploration and hydrogeologic mapping study in an effort to delineate potential aquifers. Since then the town has established a Water Supply Protection District to protect two aquifers, one at Whites Mill Pond, the other at Mill Glen, that can serve as a reserve to augment the reservoir supply. Currently, Winchendon and Ashburnham are constructing a new $6 million filtration plant to expand the safe yield of Upper Lake Naukeag.

[43] Town of Wendell Buildout Analysis, Franklin Regional Council of Government, March 2002
[44] Interview with Michael Murphy, August 24, 1998, Town of Winchendon Open Space and Recreation Plan, LandUse, Incorporated. October, 1998.

Protection Strategies

Aquifer/Watershed Protection Overlay Districts[45]

An aquifer or watershed protection overlay district protects drinking water quality and quantity by prohibiting or restricting certain uses within the district that are otherwise allowed in the underlying zoning. The MDEP regulations for new water supplies offer standards for such districts that include a list of uses to be prohibited (e.g. gasoline and automobile service stations) or permitted only if specific performance standards are met (e.g. hazardous waste facilities) within the overlay district, as well as density guidelines for new development[46]. New development is usually subject to special permit review and should meet performance standards specifically written to ensure that water quality is not impaired.

Athol, Hubbardston, Orange, and Wendell have established aquifer protection districts, and Ashburnham, Orange , and Wendell have established watershed protection districts. Winchendon has established a Groundwater Protection Overlay District and Wetlands and Floodplain Conservancy Districts with Special Use Regulations. These bylaws should be evaluated for their compliance with the DEP regulations governing protection of drinking water supplies. The remaining communities do not have such districts and may want to consider zoning changes. Moreover, the science for delineating aquifer recharge areas can be complicated, and some communities opt instead to establish a half-mile radius protection zone around their wells. These designations may not adequately protect the recharge area. Ideally, communities should retain a hydro-geologist to properly delineate the extent of the aquifer and its recharge area.

Often the recharge area for an aquifer will cross town boundaries, making it difficult to establish consistency in use regulations, performance standards or review processes between the communities. For a simple approach, towns can establish a "buffer zone" at the town boundary, to provide some transition between uses. Yet communities would be wise to adopt water supply protection districts, whether or not they draw water from municipal wells. Through an inter-municipal agreement bordering towns can pool resources to protect water supply sources that extend beyond individual corporate limits, (Templeton/Gardner, Templeton/Winchendon, and Athol/Orange) in exchange for a commitment to protect said sources. Since the designation of these districts may slightly reduce the tax base of the affected town, some slight fiscal off-set arrangements may need to be explored.

The Greater Gardner Sustainable Growth Management Plan included a recommendation to establish a collaborative agreement between the Boards of Selectmen of Ashburnham, Royalston, Templeton, Westminster, and Winchendon, the Gardner City Council, and the Montachusett Regional Planning Commission to address issues of population growth pressure, such as: increased demand for water, increased risk of contamination of surface and groundwater, incompatibilities between land uses in some communities with the water sources of others, variances in the level of protection of surface and groundwater resources. The intent of the agreement was to engage the public in discussions about water supply protection measures and draft water supply protection provisions for adoption at Town Meetings.

2. Waste Water Disposal

Historically, communities relied on centralized sewer systems where population densities warranted them. In rural areas residents managed their own wastewater through individual septic and cesspool systems. This type of waste management requires low-density development to protect groundwater resources from potential contamination, leading to a land consumptive pattern of growth sprawl. These systems have also been attributed with contaminating many recreational lakes and pond in the state.

Municipal sewer service is available to all of the urbanized areas within the Millers River Watershed. Ashburnham, Athol, Erving, Gardner, Montague, Northfield, Orange, Royalston, Templeton and Winchendon are all served by public sewage systems as well as private septic tanks. Wastewater collected through the sewer services is treated at thirteen wastewater treatment facilities. Winchendon, Gardner, Templeton, Royalston, Athol,

[45] Greater Gardner Sustainable Growth Management Plan
[46] Massachusetts Department of Environmental Protection (310 CMR 22.21 (2))

Orange, Erving, Montague, and Northfield all have treatment facilities. However, the town of Northfield treatment facility is located within the Connecticut River Watershed and does not collect water or discharge effluent within the Millers River Watershed. The Village of Millers Falls, Montague, MA has a sewer, which is connected to the Erving No. 1 facility via a conduit located underneath the Millers River.

The Millers River Watershed has four categories of sewage treatment facility ownership: Municipally Owned (MU), Privately Owned (PI), Publicly Owned (PU), and Individual On-site Ownership (ISO). The first three categories represent ownership by stockholders, private firms, or town governments, while Individual on Site Ownership refers to subsurface sewage disposal (septic systems)

The Federal Water Pollution Control Act of 1972 (Public Law 92-500) provided for federal grants that helped fund construction of eight wastewater treatment plants in the Millers River Watershed, between 1973 and 1977. The National Pollution Discharge Elimination System (NPDES) is a program established under the Federal Clean Water Act that provides for issuing, managing, terminating, monitoring, and enforcing permits for the legal discharge of pollutants into navigable waters. The permits impose pretreatment requirements that must be met by the discharger. Permit information is warehoused in databases maintained by the Environmental Protection Agency. Currently, the EPA has 25 permits on record that cover water treatment discharges, sewage discharges, and treated processed wastewater and non-contact cooling water discharges from industrial applications. MassGIS also maintains a datalayer of facilities regulated by the DEP's Bureau of Waste Management that lists the holders NPDES permits in the state. However that list is incomplete. Table IV-16 lists the holders of NPDES permits registered in the EPA databases and their addresses in the Millers River Watershed.

The watershed has ten permitted major generator wastewater treatment plants. Six of these are located in Worcester County, and four are located in Franklin County. Three permitted drinking water treatment plants are located in Worcester County, one in Ashburnham, one in Westminster, and the third in Gardner. Eight permits are issued for industrial applications. Of these, one is a fuel oil distributor, one is a used car dealer, and one is a gas station. The available permit information did not include data on what they were discharging or where it was discharged. S. Bent & Brothers in Gardner is permitted to discharge non-contact cooling water. Seaman Paper Company has a permit for treated processed wastewater. The Starrett Company has a permit for discharge of processed wastewater, likely discharging directly to the Millers River.

In many of the towns that have a municipal sewer service, portions of the sewer lines and sewer mains date back to the early part of the century. Historically, the collection systems emptied into the Millers River or its tributaries with effluent receiving little or no treatment. Today modern systems process wastewater in a variety of ways, with removal of suspended solids and biological oxygen demand as the primary treatment. Over the years towns have upgraded the systems, expanded to new areas, and added pump stations and treatment facilities. Many newer lines and infrastructure improvements were added after World War II as development extended outward from the town centers. Ongoing improvements and other repairs and modifications to inflow/infiltration (I/I) have reduced flow levels to treatment facilities. Many towns conduct I/I studies on a regular basis to ensure the treatment systems are not unnecessarily treating additional flows, especially stormwater.

Current Wastewater Systems

Ashburnham – The public sewer system serves a total of 569 properties, both homes and businesses, in the center of town and South Ashburnham roughly 23% of the population. The remaining 77% of residents rely on individual on-site septic systems. The six-year old sewage collection system pumps 318,382 gallons per day to the Gardner treatment facility on the Otter River in Templeton. Of the 251,478 gallons of water withdrawn per day in Ashburnham, only 105,000 gallons (40%) is returned through the sewers.

Unfavorable soil conditions prompted the Town to adopt large lot size zoning to protect drinking water. The moist, loamy upland soils are poor in topsoil, susceptible to erosion and unconsolidated and percolate slowly rendering them severely limited for septic systems. The numerous lakes in the town are popular both seasonally and year-round. A number of old dwellings still use outdated methods of sewage disposal and several camps

Table IV-16: National Pollution Discharge Elimination Permits in Millers River Watershed

NPDES ID	Facility Name	Address	Town	Issue Date	Expires	Description
Worcester County						
MAG640045	Ashburnham/Winchendon WTP	204 Lake Road	Ashburnham	10/27/1999		Water Supply Treatment Plant
MA0100862	Winchendon WPCF	637 River St	Winchendon	9/28/1998	10/28/2002	Sewerage Systems
MA0032450	R. B. Sahagen & Company Inc. Fuel Oil Dealers	School Street	Winchendon			
MAG640039	Fitchburg Regional Water Treatment and Storage Facility	Route 140	Westminster	8/16/1999	1/8/2000	Water Supply Filtration Plant
MA0031844	Gardner Used Auto Sales	119 Pearson Blvd	Gardner			
MA0100994	Gardner WPCF	Lower Parker St	Gardner	9/17/1998	10/17/2002	Sewerage Systems
MAG640041	Gardner WTP	100 Heywood Street	Gardner	2/18/1998	1/9/2000	Water Supply Treatment Plant
MA0002801	S Bent & Brothers Inc Wood Furniture	85 Winter Street	Gardner	9/29/1987	9/29/1992	Non-contact cooling water
MA0000469	Seaman Paper Co Of Mass Inc		Otter River	9/30/1998	10/30/2002	Treated processed waste-water
MA0100340	Templeton WWTF	Reservoir Street	Baldwinville	9/30/1999	9/30/2004	Sewerage Systems
MA0039845	Former Temple-Stuart Facility Abandoned Industrial Site	4 Holman Street	Baldwinville			
MA0102156	Templeton Developmental Center DMR Schools	212 Freight Shed Road	Baldwinville	9/30/1999	10/31/2003	Wastewater Treatment System
MA0100161	Royalston WWTP	Blossom Street	Royalston	9/29/1999	10/31/2003	Sewerage Systems
MA0001350	L.S. Starrett Company Precision Devices	121 Crescent Street	Athol	9/30/1999	10/31/2003	Processed Wastewater
MA0100005	Athol WWTP	Jones Street	Athol	9/28/1998	10/28/2002	Sewerage Systems
Franklin County						
MA0032204	Xtra Mart Convenience Store Gas Stations	293 South Main Street	Orange			
MA0101257	Orange WWTP	West Main Street	Orange	9/28/1998	10/28/2002	Sewerage Systems
MA0101052	Erving Center WWTP	Route 2	Erving	9/28/1998	10/28/2002	Sewerage Systems
MA0101516	Erving POTW # 1	16 Public Works Blvd.	Erving	9/24/1998	10/24/2002	Sewerage Systems
MA0102776	Erving POTW #3	Village Of Farley	Erving	9/29/1999	10/29/2003	Sewerage Systems

Source: Envirofacts Warehouse, Environmental Protection Agency, February 14, 2001. http://www.epa.gov/enviro/html/water.html#PCS

still use outhouses. These systems do not treat the sewage generated at the sites. The poor soil conditions and high water table also make installation of proper replacement systems difficult.[47]

Athol – Outlying rural areas of the Town have private septic systems. The wastewater collection system, located along major roadways in the Town center, dates back to the turn of the century, and serves 68% of the residential and business properties. The wastewater treatment facility on South Athol Road, built in 1970, has a design capacity of 1.75 million gallons per day and treats a wastewater volume of 1.56 million gallons per day per day. The extended aeration system consists of a grinder, a grit chamber, and four fixed aeration chambers. Over a nine-hour period sludge is distilled from the wastewater, and dried in preparation for transport to Fitchburg for incineration. Treated wastewater discharges directly to the Millers River. The Town is in planning stages for upgrades to the treatment plan and evaluation of the sewer system.

The treatment plant is experiencing sewage flows that exceed its design, due in part to water entering the system from areas outside the registered sewer connections. Infiltration of groundwater from breaks in the piping systems and inflow from direct connections such as catch basins, roof gutter leads, and leaking manhole covers can overwhelm the treatment system during major storm events causing untreated effluent to discharge to the Millers River. At present the DPW has launched a campaign to address the multiple causes of inflow and infiltration, yet despite significant efforts, much of the oldest portion of the system still needs repair or replacement.

[47] Ashburnham Open Space and Recreation Plan, 2001.

Erving – The wastewater treatment system is comprised of three water treatment plants that use a modified activated sludge process. It serves about 60% of the population. The remaining population relies on private septic systems. The largest facility, located in Erving Center, has a design capacity of 3.15 million gallons per day. Between the three facilities, the system treats 2 million gallons per day. Treated water is discharged directly to the Millers River. The sewer collection system is less than 25 years old.

Gardner – The Sewage Treatment Plant is located in the Town of Templeton, west of the Otter River. The wastewater collection and treatment system serves over 90 percent of the city's residents as well as the collection system in Ashburnham. The treatment system consists of primary sedimentation, trickling filtration, secondary sedimentation and postchlorination. Sludge is dried and disposed of in sanitary landfills. Phosphorus is removed and the effluent is dechlorinated prior to discharge. Present capacity of the system is 4.3 million gallons per day. [48] The Five-Year Action Plan In the City's 2000 Open Space and Recreation Plan includes plans for extending the sewer service to the municipal golf course and to residents in the immediate vicinity.

Hubbardston – The town has no sewage treatment system. All properties rely on private individual septic systems.

Orange - The Town's sewer system includes one wastewater treatment plant and a collection system that dates back to the 1890's. Orange upgraded the treatment facility in the late 1990's. These improvements included increasing the capacity of the pumps, a new fine bubble aeration system, and upgrades to the return activated sludge controls. These improvements resulted in an increase in the design capacity of the plant for handling hydraulic flow, which is the water entering the plant, from 1.1 MGD to 1.35 MGD. The age of the sewer pipes has contributed to problems of infiltration and inflow (I & I). Infiltration is groundwater entering cracked pipes and inflow is storm water getting into the pipes from cracked manholes and other sources. Fixing I & I problems can be an expensive proposition. One main section of pipe has been recently repaired and according to the Chief Operator, Larry Adams, the wastewater treatment plant has seen a significant reduction in hydraulic flow.

The Town of Orange recently funded a Comprehensive Wastewater Treatment Master Plan that looked at potential future expansions of the sewer system. These may include extensions down the four main roadways entering Orange Center and expansions to Lake Mattawa and North Orange. According to the Chief Operator the most important issues for the future include a number of collection system improvements and a second phase of construction projects over the next two to three years. These include flow equalization, grit removal, an additional clarifier, and a new aeration and disinfection system.

The public sewer system can impact development in a number of ways. First, where new sewer lines go, development will follow. Sewer infrastructure should be expanded to ensure that new industrial development occurs away from sensitive natural resources and that new dense residential development is built ideally within a Town-mandated boundary. Secondly, due to new Title 5 regulations, Towns may be inclined to rescue residents with problem sewer systems. Expanding sewer to areas with physical and hydrogeologic constraints may open up other areas to future development. Third by expanding sewer lines the cost of upkeep and repair to the Town of Orange, particularly with respect to infiltration and inflow problems, increases. In addition, new demand for public sewer service may require further expansion of the wastewater treatment capacity, which can be very expensive. The point is that public sewer systems can be a valuable tool for controlling and, in a sense, rewarding dense residential development that remains close to existing infrastructure. On the other hand expanding sewer can create a major drain on the Town budget due to repair costs and the costs of future community services that will be the result of expanding sparse yet sewered residential development in rural outlying areas.

[48] Water Supply and Wastewater, the Regional Plan, Montachusett Regional Planning Commission, Curran Associates, Inc.

Petersham – The town has no public sewage system. Residents dispose of wastewater through septic tanks.

Phillipston – The town has no public sewage system. Households in the town depend upon private septic systems for sewage disposal. Many seasonal camps sited on Queen Lake have been converted to year-round homes without upgrading the private septic systems. Failing septic systems may potentially pollute private wells and Queen Lake. The potential for increased development in the town has led to concerns that groundwater resources and wetlands are vulnerable to contamination and encroachment.

Royalston – The twenty-eight year old wastewater treatment system, located in South Royalston, serves the village along the Millers River. The wastewater treatment facility, located on Blossom Street, treats 5,000 gallons of wastewater per day. The system consists of an open tank and a chlorination process, and has a design capacity of 15,000 gallons per day. After treatment, the effluent discharges directly to the Millers River. In 1999 the sewer lines were upgraded. Most of the town is upland and rural and 85% of the population relies on private septic systems.

Templeton – The twenty-eight year old wastewater treatment facility, located on Reservoir Street in Baldwinville treats 280,000 gallons of wastewater per day, and serves 30 percent of the total population. Built in 1979, the treatment plant has a design capacity of 2.8 million gallons per day. The facility uses both primary and secondary treatment processes and discharges treated outflow directly to the Otter River. Byproducts are disposed of on a 20-acre landfill on Reservoir Street in Baldwinville. Seventy percent of the population must rely on private individual septic systems.

Westminster – Sewer service in Westminster is provided through an agreement with the City of Fitchburg. The service has 516 sewer connections, mostly in the center of town, serving roughly 25% of the population. Everyone else is on individual septic systems. Sewage is treated at East Plant, located in the City of Fitchburg, which discharges treated water in the Nashua River Watershed. Very little of the sewage disposal affects the Millers River Watershed. The system processes 111, 836 gallons of wastewater per day, but has the capacity to process up to 250,000 gallons per day. Two large pumps were installed in 1999 that can pump up to 500 gallons per minute. Plans for expansion include a 5-mile sewer expansion to serve Ellis Road, Scenic Drive and Gatehouse Road. Voters recently approved additional sewer lines to serve West Main Street, as well. Less than 34 percent of the water withdrawn from the public water supply is returned through the sewer system.

The portion of Westminster that is within the Millers River Watershed is discussed in the Westminster 2000 Master Plan as an area currently under development pressure. Most new residential construction is taking place on ANR lots, and the Plan recommends the use of cluster and planned unit development to preserve the rural character. The Zoning Bylaw provides for application to the Board of Appeals for a special permit excepting subdivision plans from the lot area and frontage restrictions. These development methods generally increase the density of residential units in one area in exchange for open space set-asides in another. The increased density can be accommodated with the use of decentralized wastewater treatment systems that can efficiently and cost-effectively treat between 1,000 and 50,000 gallons per day. Essentially, ordinary septic tanks are connected to a multiple user collection system and a leaching system. Over 15,000 gallons per day, the system is required to have a nitrogen reduction system.

Winchendon – The wastewater treatment facility serves 33% of the Town's population, the remaining population relies on private individual septic systems. Built in 1974, the wastewater system was designed to treat 0.5 million gallons of wastewater per day. Treated effluent discharges directly to the Millers River. It has been operating over capacity at 680 million gallons per day since it went on line. The plant has not been upgraded since it went on line, and has exceeded its design life. The eighty-year old collection system needs work, as well. During major storm events, the 34 manholes (storm/sewer combined) could fail to maintain separation. Stormwater can flood the sewer system causing raw sewage to be discharged to the Millers River.

Since the 1987 Open Space and Recreation Plan, the town has recognized the need to extend its sewer system to accommodate the growth in residential development and attract industrial development outside the village center. Winchendon is in the engineering phase of a $5 million rehabilitation of the sewerage collection system and the treatment plant that will increase capacity from 500,000 gallons per day to 1.2 million gallons per day. Plans include interceptor replacement. The town identified the villages of Waterville and Winchendon Springs

as areas where future sewer extensions could mitigate failures of residential septic systems. The town has also embarked on a program to address inflow and infiltration problems by eliminating illegal connections to the sewer system. The effort will help to mitigate pollution of Whitney pond and the Millers River.[49]

Septic Systems

Realizing the danger posed by failing septic systems, The Montachusett Regional Planning Commission has taken the lead by tapping into a Massachusetts Department of Environmental Protection program that offers grants to low and moderate income residents who cannot afford to install septic systems that meet Title 5 compliance standards. During 1999, MRPC oversaw the installation of 27 septic systems in Ashburnham, Townsend, Phillipston and Royalston households.

[49] Town of Winchendon Open Space and Recreation Plan, 1998, Land Use Incorporated.

3. Bridges and Roads

The topography, road surface type, and distance to nearby water sources all affect the impact that roads can have on water quality. Many rural roads follow the courses of rivers and streams and untreated stormwater run-off discharges to these waterbodies. The runoff from dirt roads can carry debris and sediment. Contaminants from vehicles and summer and winter roadway maintenance can wash into wetlands and waterways during rain-storms and periods of rapid snow melt. In more urbanized areas, stormwater runoff from paved roads is often channeled to the nearby waterways at greater velocities, carrying silt, road maintenance chemicals, and motor vehicle residue. Excessive debris sediment and stormwater velocity can erode stream banks and destroy valu-able habitat.

The road infrastructure of the watershed is comprised of several state highways (Route 2, Route 2A, Route 12, Route 140, Route 68, Route 101, Route 32, Route 202, Route 122, Route 78, and Route 63), and a network of local roads serving town centers and rural residential areas. Cars and trucks are the primary modes of transpor-tation for people and goods. Relatively low population densities and the distance to major urban centers like Boston limit the potential for public transit as a travel mode.

State Route 2, or the Old Mohawk Trail, is the principal east-west highway across northern Massachusetts, link-ing Boston to the State of New York and providing access to Interstate 91 in Greenfield. It is a controlled ac-cess highway through eastern Massachusetts until it reaches Erving, where it becomes more like a local street. One of the oldest designated tourist and scenic routes in the country; the Mohawk Trail passing through a num-ber of wetland areas between Gardner and Athol, and parallels the course of the Millers River from Athol to Montague. Route 2 is part of the National Highway System (NHS) and is thus eligible for federal funding.

Route 2A is another east-west roadway that runs parallel to Route 2 through much of the Montachusett and Franklin County regions. Route 2A serves the towns of Gardner, Templeton, Phillipston, and Orange on a course that runs somewhat parallel to Route 2 but it connects town centers.

Routes 12, 140, 68, 32, 122, 78, and 63 are north-south roadways that provide link between the Massachusetts border communities, Route 2, southern Worcester County, Franklin County, and Pioneer Valley. Route 122, a scenic state road provides direct access between Worcester, Petersham, and New Salem. Smaller highways and local roadways such as Route 68 usher people to and from Gardner and Worcester. Route 68 also connects the villages of Royalston and Templeton, providing an important corridor in a rural area. Originating in New Hampshire, Route 202 joins Route 2 in Phillipston and Athol before continuing on a southwesterly route to the City of Holyoke.

The state road inventory classifies roads according to whether they are paved or unpaved and public or private. Public roads are further classified by jurisdiction: Federal, State, or Local. Paved roads have some type of sur-face treatment such as asphalt or concrete and they typically have stormwater drainage systems incorporated into their design to improve the safety of the roads. In the past, design standards for stormwater management simply directed the stormwater away from the road and into nearby waterways without treatment. Today, these standards are changing. In urbanized areas stormwater is directed into collection systems and, in some cases is treated before being discharged. Unpaved roads consist of graded earth or gravel and can be subject to erosion. Many of these are old farm roads or logging trails. Often they traverse areas of steep gradient or cross small streams. Drainage problems can undermine the quality of unpaved roads and degrade the water quality of rivers and streams.

According to the Road Inventory File maintained by MassHighway and MassGIS, the Millers River watershed contains over 850 miles of roadways. Approximately 159 miles (19 percent) of these roads are unpaved. Most of these unpaved roads (≅ 109 miles) are under the jurisdiction of the municipalities. Royalston has the most unpaved road mileage at 25 miles, followed by Winchendon (17.5), Warwick (15.8), Orange (12.1), Wendell (11.6), and Athol (10.8). Almost 31 miles of unpaved roads pass through State parks. Most of these roads are located in Wendell, Erving, and Warwick. Approximately 19 miles of unpaved roads are unaccepted by either MassHighway or the local communities.

Table IV-17: Paved and Unpaved Road Mileage Within the Millers River Watershed

Jurisdiction	Mass Highway	City/Town		State Park		State Inst.		US ACOE	Unaccepted		Total	
		Paved	Unpaved	Paved	Unpaved	Paved	Unpaved	Paved	Paved	Unpaved	Paved	Unpaved
Worcester County												
Ashburnham	4.8	21.5	5.1						7.5	5.6	**33.8**	**10.7**
Athol	13.8	85.8	10.8						0.3	1.9	**99.9**	**12.7**
Gardner	16.2	91.0	1.1			3.73			2.9	1.8	**113.8**	**2.9**
Hubbardston		6.9	0.8					0.4	0.2	0	**7.5**	**0.8**
Phillipston	8.7	19.4	4.5						0.3		**28.4**	**4.5**
Royalston		44.3	25.7					1.4	0.1	0.5	**45.8**	**26.2**
Templeton	27.1	65.7	2.6	0.4	1.1	3.4	0.9		3.9	3.3	**100.5**	**7.9**
Westminster	2.5	6.8				1.41			0.3	0.4	**11.0**	**0.4**
Winchendon	12.1	75.5	17.5	0.3	5				2.2	1.9	**90.1**	**24.4**
Franklin County												
Erving	12.7	15.8	1.2	2.7	4.6				0.3	0.7	**31.5**	**6.5**
Orange	15.1	71.9	12.1		0.6				2.4	1.3	**89.4**	**14**
Warwick		25.1	15.8	1.2	4.6					1.5	**26.3**	**21.9**
Wendell	0.3	14.6	11.6	0.5	14.8				0.1	0.5	**15.5**	**26.9**
Total Mileage	**113.3**	**544.5**	**108.8**	**5.1**	**30.7**	**8.5**	**0.9**	**1.8**	**20.5**	**19.4**	**693.7**	**159.0**

Source: MassHighway Road Inventory File, MassGIS Datalayer

Map: Millers River Watershed Transportation Infrastructure

A comprehensive guide on protecting water quality through Best Management Practices for unpaved roads was developed by the Berkshire Regional Planning Commission for the Massachusetts Department of Environmental Protection.[50] For unpaved roads, proper design and routine inspection and maintenance must accommodate good drainage systems. The profile of the road must allow for removal of water from the surface of the road. Proper grading is required to maintain an even surface and alleviate water related surface deformations. Ditches alongside the road should be employed to convey runoff away from the road and to filter sediments and pollutants from the runoff. In areas with steeper slopes waterbars can effectively channel runoff away from the road and prevent deterioration of the road surface. Proper placement of culverts to drain water away from ditches will help to preserve the road base. Culvert design should accommodate both high water periods and fish passage. Outlet protection should be employed to control the velocity of water in ditches and culverts. Bank stabilization measures should be employed in sloped areas at risk of erosion.

Roads quite often must be built across waterways and wetlands. Bridges that span these waterways often contribute significant road related pollutants as runoff drains from bridge decks. Bridge maintenance activities can also contribute pollutants, such as paints, solvents, cleaners and rust.

In an effort to control surface runoff, erosion, and streambed scouring, the US Environmental Protection Agency developed guidance specifying management measures for sources of nonpoint pollution in coastal waters, as required under section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). It provides guidance to States and Territories on the types of management measures that should be included in State and Territorial Coastal Nonpoint Pollution Control Programs. One component of the guidance establishes management measures for the siting, design, and maintenance of bridge structures so that sensitive and valuable aquatic ecosystems are protected from adverse effects of NPS runoff impacts from bridge decks. Bridge structures should be located in alternative areas where only minimal environmental damage would result.[51]

Measures include minimizing the use of scuppers on bridges, and conveying deck drainage to land for treatment. Scupper drains allow direct discharge of runoff into surface waters below the bridge deck. On bridges with scupper drains, runoff should be treated to reduce pollutant load, and reduction efforts should be applied elsewhere on the project to compensate for the loading discharged off the bridge. Bridge design should account for potential scour and erosion, which may affect bottom sediments and shellfish beds. Bridge decks should be designed to keep runoff velocities low and control pollutant loadings. Runoff waters should be conveyed away from contact with the watercourse and directed to a stable storm drainage, wetland, or detention pond. Conveyance systems should be designed to withstand the velocities of projected peak discharge. Storm drainage systems should not discharge to the watercourse.[52]

Bridges are often susceptible to the geomorphic and hydraulic characteristics of the waterbodies they span. These characteristics affect stream stability and can result in serious scour problems that affect the safety of the bridge. Scouring of the streambed around abutments during flood events can result in bridge failures. Factors affecting bridge failures include stream meandering and the movement of streambed material during turbulent periods such as spring snowmelt and major floods.

In 1989, the Federal Highway Administration required states to evaluate the vulnerability of bridges over water to flood damage. To comply with this mandate, MassHighway and the US Geological Survey commenced a project in 1992 to assess the stream stability and streambed scour at all bridges longer than 20 feet. Field assessors used historic data on bridge location and other key identifiers, bridge structure and use, and geophysical characteristics to locate the bridges, and create an assessment database. Location information was supplemented with latitude and longitude coordinates derived from Global Positioning System measurements in the field. The data is available on CD-ROM from US Geological Survey.[53]

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[50] Berkshire Regional Planning Commission, *The Massachusetts Unpaved Roads BMP Manual,* MA DEP and U.S. EPA, Region 1, Winter 2001.
[51] http://www.epa.gov/OWOW/NPS/MMGI/Chapter1/ch1-1.html
[52] ibid.
[53] Stream Stability and Scour Assessments at Bridges in Massachusetts, Gene W. Parker, Lisa Bratton, and David Armstrong, US Geological Survey, Open-File Report 97-558

MassHighway used the assessments to prioritize the bridge inventory for addressing scour damage. Scour ratings in the Millers River Watershed range from 0.00 to 7.54. A low scour rating means a high vulnerability to scour. Table IV-18 was created from the 1992 MassHighway/USGS study.

Numerous bridges throughout the watershed were not assessed in the MassHighway/USGS study. These may have been bridges that had spans less than twenty feet, or they may simply have not been included at the time of the study. Table IV-19 lists these bridges. It may be worthwhile to investigate these bridges to determine if there is a runoff impact affecting the waterbodies.

Table IV-18: Scour Rating of Selected Millers River Watershed Bridges

Town	Bridge No.	Over	Under	Scour Rating	Owner
Ashburnham	A11001	HWY SHERBERT RD	WATER BR MILLERS RIVER	6.59	Town Agency
Ashburnham	A11010	HWY DUNN ROAD	WATER BR MILLERS RIVER	5.92	Town Agency
Ashburnham	A11016	HWY LAKE ROAD	WATER WATATIC LAKE OUTLT	5.65	Town Agency
Ashburnham	A11017	HWY CROSS ROAD	WATER WATATIC LAKE OUTLT	5.03	Town Agency
Ashburnham	A11023	HWY LAKESHORE DR	WATER WATATIC LAKE INLET	4.54	Unknown
Athol	A15020	HWY DANIEL SHAYS	WATER MILLERS RIVER	7.54	State Highway Agency
Athol	A15008	HWY CRESCENT ST	WATER MILLERS RIVER	7.22	Town Agency
Athol	A15035	ST 2	WATER SWAMP	7.22	State Highway Agency
Athol	A15045	HWY CANAL STREET	WATER MILL BROOK	7.22	Town Agency
Athol	A15017	HWY LOGAN ROAD	WATER EBR TULLY RIVER	6.73	Town Agency
Athol	A15027	HWY NEW SHRBRN R	WATER ELLINWOOD BROOK	6.59	Town Agency
Athol	A15030	ST 2	WATER LAKE ROHUNTA	6.59	State Highway Agency
Athol	A15004	HWY MORGAN AVE	WATER S ATHOL PND OUTLET	5.65	Town Agency
Athol	A15046	HWY SOUTH STREET	WATER MILL BROOK	5.65	Town Agency
Athol	A15007	HWY EXCHANGE ST	WATER MILLERS RIVER	5.17	Town Agency
Athol	A15016	HWY PINEDALE AVE	WATER EBR TULLY RIVER	5.03	Town Agency
Athol	A15021	HWY DANIEL SHAYS	WATER LAKE ROHNTA OUTLET	5.03	State Highway Agency
Athol	A15009	ST 32 CHESNT HL AV	WATER MILLERS RIVER	4.94	Town Agency
Athol	A15006	ST 2A S. MAIN ST	WATER MILLERS RIVER	4.05	State Highway Agency
Athol	A15018	ST 2 A	WATER WEST BROOK	3.23	State Highway Agency
Athol	A15005	HWY WASHNGTN AVE	WATER S ATHOL PND OUTLET	1.94	Town Agency
Erving	E10027	Crescent Street	KEYUP BROOK	7.54	
Erving	E1005	Paper Mill Road	MILLERS RIVER	7.12	
Erving	E10014	French King Highway (Rt 2)	CONNECTICUT RIVER	6.47	
Erving	E10011	Church Street	MILLERS RIVER	4.35	
Erving	E1008	Arch Street	MILLERS RIVER	3.94	
Erving	E1006	Farley Road	MILLERS RIVER	3.86	
Erving	E10002	Bridge Street (St Rt 63)	MILLERS RIVER	1.03	
Gardner	G01002	HWY BRIDGE ST	WATER OTTER RIVER	-	City/Municipal Highway A
Gardner	G01001	ST101 GARDNER RD E	WATER OTTER RIVER	7.22	State Highway Agency
Gardner	G01023	HWY TRAVERS ST	WATER TRAVERS POND OTLT	5.65	City/Municipal Highway A
Gardner	G01041	ST 68 TIMPANY BLVD	WATER MILL BROOK	5.65	City/Municipal Highway A
Gardner	G01049	ST 2 EB & WB	WATER OTTER RIVER	5.65	State Highway Agency
Gardner	G01003	ST 2 A	WATER BENT TRAVERS POND	5.17	State Highway Agency
Gardner	G01022	HWY MILL ST	WATER BAKER BROOK	5.03	City/Municipal Highway A
Gardner	G01024	ST 68 WEST ST	WATER BAILEY BROOK	4.72	State Highway Agency
Gardner	G01019	HWY MILL ST.	WATER BAKER BROOK	4.41	City/Municipal Highway A
Gardner	G01021	HWY MILL STREET	WATER BAKER BROOK	2.88	City/Municipal Highway A

Town	Bridge No.	Over	Under	Scour Rating	Owner
Gardner	G01017	HWY WINTER ST	WATER BAKER BROOK	2.68	City/Municipal Highway A
Montague	M28035	Davis Road	Lyons Brook	5.2	
Montague	M28041	Mormon Hollow Road	Lyons Brook	5.03	
Orange	O03009	Holtshire Rd	MILLERS RIVER	6.25	
Orange	O03025	Wendell Depot Rd (Rt 2)	MILLERS RIVER	5.88	
Orange	O03011	West Main Street	Moss Brook	5.58	
Orange	O03004	Tully Road	West Branch Tully River	5.48	
Orange	O03012	Warwick Road	Orcutt Brook	4.23	
Orange	O03005	Tully Road	West Branch Tully River	3.74	
Orange	O03003	Royalston Road	TULLY RIVER	3.23	
Orange	O03008	St Rt 122	MILLERS RIVER	3.12	
Orange	O03010A	Wendell Depot Road	North Channel Millers River	3.75	
Orange	O03010B	Wendell Depot Road	North Channel Millers River	3.75	
Royalston	R12012	HWY DELAND RD	WATER PRIEST BROOK	-	Unknown
Royalston	R12014	HWY KING STREET	WATER MILLERS RIVER	-	Town Agency
Royalston	R12009	HWY N FITZWLM RD	WATER LAWRENCE BROOK	7.22	Town Agency
Royalston	R12006	HWY N FITZWLM RD	WATER LAWRENCE BROOK	5.65	Town Agency
Royalston	R12021	ST 68 WARWICK ROAD	WATER EBR TULLY RIVER	5.65	Town Agency
Royalston	R12007	HWY ATHOL RD	WATER LAWRENCE BROOK	5.43	Town Agency
Royalston	R12013	HWY WINCHNDON RD	WATER PRIEST BROOK	5.26	Town Agency
Royalston	R12015	ST 68 ROYALSTON RD	WATER MILLERS RIVER	4.72	Town Agency
Royalston	R12002	ST 68 ROYALSTON RD	WATER LAWRENCE BROOK	4.54	Town Agency
Royalston	R12018	HWY OLD TPIKE RD	WATER SCOTT BROOK	4.54	Town Agency
Royalston	R12001	HWY STOCKWELL RD	WATER LAWRENCE BROOK	2.45	Town Agency
Royalston	R12004	HWY NE FITZWM RD	WATER LAWRENCE BROOK	1.96	Town Agency
Templeton	T02004	HWY MAIN ST N	WATER OTTER RIVER	6.77	Town Agency
Templeton	T02017	HWY PARTRDGVL RD	WATER PARTRIDGE PND OTLT	6.59	Town Agency
Templeton	T02014	ST 68 GARDNER RD	WATER BR OTTER RIVER	5.65	State Highway Agency
Templeton	T02005	HWY HMLET MLL RD	WATER OTTER RIVER	5.48	Town Agency
Templeton	T02019	HWY N MAIN ST	WATER E TEMPLTN PND OTLT	5.03	Town Agency
Templeton	T02002	US202 ELM ST	WATER OTTER RIVER	4.01	State Highway Agency
Warwick	W08005	Wendell Road	Moss Brook	5.97	
Warwick	W08004	Warwick Road	Orcutt Brook	2.76	
Winchendon	W39004	HWY GLENALLEN ST	WATER MILLERS RIVER	7.14	Town Agency
Winchendon	W39013	HWY HIGH ST	WATER MILLERS RIVER	7.14	Town Agency
Winchendon	W39002	US202 MAPLE ST	WATER MILLERS RIVER	6.25	State Highway Agency
Winchendon	W39001	HWY HARRIS ROAD	WATER NBR MILLERS RIVER	5.88	Town Agency
Winchendon	W39020	ST 12 SPRING ST	WATER MILLERS RIVER	5.03	State Highway Agency
Winchendon	W39036	HWY MONOM DR WST	WATER NBR MILLERS RIVER	4.72	Town Agency
Winchendon	W39018	US202 GLENALLN ST	WATER NBR MILLERS RIVER	3.87	State Highway Agency
Winchendon	W39006	HWY BROWN STREET	WATER MILLERS RIVER	3.74	Town Agency
Winchendon	W39015	HWY N ROYLSTN RD	WATER WBR MILLERS RIVER	3.37	Town Agency
Winchendon	W39012	ST 12 SPRING ST	WATER MILLERS RIVER	2.43	State Highway Agency
Winchendon	W39007	US202 RIVER ST.	WATER MILLERS RIVER	2.4	State Highway Agency
Winchendon	W39005	HWY RIVER ST	WATER MILLERS RIVER	1.63	Town Agency
Winchendon	W39021	ST 12 SPRING ST	WATER MILLERS RIVER	0.49	Unknown

Source: Stream Stability and Scour Assessments at Bridges in Massachusetts, Gene W. Parker, Lisa Bratton, and David Armstrong, US Geological Survey, Open-File Report 97-558.

Table IV-19: Unrated Bridges in Millers River Watershed

Town	Bridge No.	Over	Under	Owner
Ashburnham	A11008	HWY WILLIAMS RD	WATER GROSS POND OUT	Unknown
Ashburnham	A11002	HWY SHERBERT RD	WATER MILLERS RIVER	Town Agency
Ashburnham	A11003	HWY WHITNY HL RD	WATER PHILLIPS BROOK	Town Agency
Ashburnham	A11004	HWY PUFFER ST	WATER PHILLIPS BROOK	Town Agency
Ashburnham	A11006	HWY MILL ST	WATER PHILLIPS BROOK	Town Agency
Ashburnham	A11007	ST101 ASHBY RD	WATER PHILLIPS BROOK	Town Agency
Ashburnham	A11009	HWY DEPOT ROAD	WATER MILLERS RIVER	Town Agency
Ashburnham	A11011	HWY TUCKERMAN RD	WATER BLUEFIELD BROOK	Town Agency
Ashburnham	A11012	HWY YOUNG ROAD	WATER BLUEFIELD BROOK	Town Agency
Ashburnham	A11013	HWY DUNN ROAD	WATER BLUEFIELD BROOK	Town Agency
Ashburnham	A11014	HWY DUNN ROAD	WATER BLUEFIELD BROOK	Town Agency
Ashburnham	A11018	HWY WILLIAMS RD	WATER WHITMAN RIVER	Town Agency
Ashburnham	A11019	HWY WESTMINSTR S	WATER WHITMAN RIVER	Town Agency
Ashburnham	A11020	ST101 CENTER ST	WATER WHITMAN RIVER	Town Agency
Ashburnham	A11021	HWY RINDGE TNPK	WATER WARD POND OUTLET	Town Agency
Ashburnham	A11022	HWY WILLIAMS RD	WATER WHITMAN RIVER	Town Agency
Ashburnham	A11023	HWY LAKESHORE DR	WATER WATATIC LAKE INLET	Town Agency
Ashburnham	A11005	ST 12 FITCHBURG RD	WATER PHILLIPS BROOK	State Highway Agency
Ashburnham	A11024	ST 12 WINCHENDON	WATER CHESHIRE POND OTLT	State Highway Agency
Athol	A15002	HWY BROOKSIDE RD	WATER WEST BROOK	Town Agency
Athol	A15019	HWY CHESTNUT ST	WATER MILL BROOK	Town Agency
Athol	A15022	HWY WHITES PND R	WATER WHITES POND OUT	Town Agency
Athol	A15023	HWY NEW SHRBRN R	WATER RICEVILLE BROOK	Town Agency
Athol	A15024	HWY S ATHOL RD	WATER RICEVILLE BROOK	Town Agency
Athol	A15026	HWY DOE VALLEY R	WATER ELLINWOOD BROOK	Town Agency
Athol	A15037	HWY S ATHOL RD	WATER ELLINWOOD BROOK	Town Agency
Athol	A15042	HWY S ATHOL RD	WATER MILL BROOK	Town Agency
Athol	A15047	HWY FREEDOM ST	WATER MILL BROOK	Town Agency
Athol	A15098	HWY FREEDOM ST	WATER ABANDONED CANAL	Town Agency
Athol	A15099	HWY EXCHANGE ST	WATER UNDERGROUND BRK	Town Agency
Athol	A15029	ST 32 PTRSHAM RD	WATER MILL BROOK	State Highway Agency
Athol	A15043	ST 32 TULLY LNK DAM	WATER EB TULLY RIV SPLWY	Corps of Engineers
Athol	A15043	MA ROUTE 32	SPILLWAY CHANNEL	Corps of Engineers
Erving	E10001	East Mineral Road	MILLERS RIVER	
Gardner	G01052	HWY HIGH ST	WATER GREENWOOD BROOK	Unknown
Gardner	G01053	HWY HIGH ST.	WATER GREENWOOD BRK	Unknown
Gardner	G01028	HWY RIVERSIDE RD	WATER OTTER RIVER	Town Agency
Gardner	G01014	ST 68 WEST ST	WATER WILDER BROOK	State Highway Agency
Gardner	G01015	ST 68	WATER PERLEY BROOK	State Highway Agency
Gardner	G01018	STA G150&45	WATER OTTER RIVER	State Highway Agency
Gardner	G01030	ST 68 & 140	WATER FOSTER BROOK	State Highway Agency
Gardner	G01038	ST2 E BOUND	WATER PEW BROOK	State Highway Agency
Gardner	G01039	ST2 A WINTER ST	WATER FOSTER BROOK	State Highway Agency
Gardner	G01040	ST140 PEARSON BLVD	WATER FOSTER BROOK	State Highway Agency
Gardner	G01046	ST140 GREEN ST	WATER WILDER BROOK	State Highway Agency
Gardner	G01047	ST140 GREEN ST	WATER PERLEY BROOK	State Highway Agency
Gardner	G01989	ST 2 STA G14+40	WATER SNAKE POND INLT	State Highway Agency
Gardner	G01994	ST 2A W BROADWAY	WATER STREAM	State Highway Agency

Town	Bridge No.	Over	Under	Owner
Gardner	G01995	ST 2A W BROADWAY	WATER POND BROOK	State Highway Agency
Gardner	G01997	ST 68 TIMPANY BLVD	WATER POND BROOK	State Highway Agency
Gardner	G01998	ST 2A E BROADWAY	WATER WRIGHT RES OVRFLOW	State Highway Agency
Gardner	G01999	ST 2 & RAMPS	WATER FOSTER BROOK	State Highway Agency
Gardner	G01016	HWY MECHANIC ST	WATER POND BROOK	City/Municipal Highway A
Gardner	G01020	HWY CLARK STREET	WATER PERLEY BROOK DAM	City/Municipal Highway A
Gardner	G01025	HWY KEYES ROAD	WATER WILDER BROOK	City/Municipal Highway A
Gardner	G01029	HWY PEARSON BLVD	WATER PEW BROOK	City/Municipal Highway A
Gardner	G01044	HWY CLARK ST	WATER BAILEY BROOK	City/Municipal Highway A
Gardner	G01045	HWY SOUTH MAIN S	WATER FOSTER BROOK	City/Municipal Highway A
Gardner	G01992	HWY CLARK ST	WATER WILDER BROOK	City/Municipal Highway A
Gardner	G01993	HWY EATON ST	WATER CRYSTAL LAKE OUT	City/Municipal Highway A
Gardner	G01996	HWY JOHN ST	WATER POND BROOK	City/Municipal Highway A
Phillipston	P09001	US202 & ST 2A	WATER BEAVER BROOK	Unknown
Phillipston	P09003	ST2 A MOHAWK TRA	WATER KENDALL BROOK	Unknown
Phillipston	P09008	ST2	WATER BEAVER BROOK	Unknown
Phillipston	P09009	US202 & ST 2A	WATER BEAVER BROOK	Unknown
Phillipston	P09002	ST101 QUEEN LK RD	WATER BURNSHIRT RIVER	Town Agency
Royalston	R12010	HWY WARWICK RD	WATER BOYCE BROOK	Unknown
Royalston	R12015	ST 68 ROYALSTON RD	WATER MILLERS RIVER	Unknown
Royalston	R12024	HWY UNNAMED ROAD	WATER BOYCE BROOK	Unknown
Royalston	R12025	HWY WINCHENDON R	WATER BOYCE BROOK	Unknown
Royalston	R12016	HWY STONE ROAD	WATER BEAVER BROOK	Town Agency
Royalston	R12017	HWY BROWN ROAD	WATER BEAVER BROOK	Town Agency
Royalston	R12019	HWY TURNPIKE RD	WATER TOWNE BROOK	Town Agency
Royalston	R12020	HWY FALLS ROAD	WATER BOYCE BROOK	Town Agency
Royalston	R12023	HWY FALL ROAD	WATER FALLS BROOK	Town Agency
Royalston	R12027	HWY FALLS RD	WATER E BR TULLY R	Town Agency
Royalston	R12028	HWY NEW BOSTN RD	WATER BR BEAVER BROOK	Town Agency
Royalston	R12029	HWY NEW BOSTN RD	WATER BR BEAVER BROOK	Town Agency
Royalston	R12030	HWY BRCH HL D RD	WATER BEAVER BROOK	Town Agency
Royalston	R12022	HWY DOANE HIL RD	WATER TULLY RIVER	Corps of Engineers
Royalston	R12022	DOANE HILL ROAD	TULLY RIVER	Corps of Engineers
Templeton	T02002	US202 ELM ST	WATER OTTER RIVER	Unknown
Templeton	T02018	HWY PLEASANT ST	WATER E TEMPLTN PND OTLT	Town Agency
Templeton	T02969	HWY ELM ST	WATER OTTER RIV TRIB	Town Agency
Templeton	T02970	HWY OTTER RIV RD	WATER OTTER RIV TRIB	Town Agency
Templeton	T02971	HWY LORD RD	WATER RIDGLY POND INLT	Town Agency
Templeton	T02972	HWY DEPOT ST	WATER RIDGLY POND OUT	Town Agency
Templeton	T02973	HWY N MAIN ST	WATER OTTER RIV TRIB	Town Agency
Templeton	T02974	HWY S MAIN ST	WATER TROUT BRK TRIB	Town Agency
Templeton	T02975	OLD ROYLSTON RD	WATER BROUT BRK	Town Agency
Templeton	T02976	ST 68 RYLSTN RD	WATER NORCROSS BRK	Town Agency
Templeton	T02977	HWY GAVINS RD	WATER NORCROSS BRK	Town Agency
Templeton	T02983	HWY SOUTH RD	WATER CAESTO BRK	Town Agency
Templeton	T02984	HWY HENSHAW RD	WATER STONE POND TRIB	Town Agency
Templeton	T02985	HWY STNY BRDG RD	WATER STONEY BRG PND	Town Agency
Templeton	T02986	HWY BARRE RD	WATER STONE BRDG PND IN	Town Agency
Templeton	T02988	HWY BRKS VLLG RD	WATER HADLEY POND IN	Town Agency

Town	Bridge No.	Over	Under	Owner
Templeton	T02989	HWY BROOKS VLLGE R	WATER BRAZELL PND OUT	Town Agency
Templeton	T02996	HWY WHITNEY ST	WATER HUBBARDSTN BRK	Town Agency
Templeton	T02997	HWY NYMAN RD	WATER TEMPLTN PND OUT	Town Agency
Templeton	T02013	US202 &STA 68	WATER TROUT BROOK	State Highway Agency
Templeton	T02029	ST2 STA 107	WATER TROUT BROOK	State Highway Agency
Templeton	T02030	ST2 EB STA 238	WATER E TMPLTN POND	State Highway Agency
Templeton	T02030	ST 2 WB STA 238	WATER E TMPLTN POND	State Highway Agency
Templeton	T02978	US202 STA T120	WATER CROW HILL BRK	State Highway Agency
Templeton	T02979	US202 STA 116+50	WATER CROW HILL BRK	State Highway Agency
Templeton	T02980	US202 STA T115	WATER CROW HILL BRK	State Highway Agency
Templeton	T02981	US202	WATER CROW HILL BRK	State Highway Agency
Templeton	T02982	ST 2A ATHOL RD	WATER BOURN-HADLEY POND	State Highway Agency
Templeton	T02987	ST 2A STA T155+00	WATER TROUT BRK TRIB	State Highway Agency
Templeton	T02990	ST 2A ATHOL RD	WATER BROOK	State Highway Agency
Templeton	T02991	ST 2A ATHOL RD	WATER PINE POND OUT	State Highway Agency
Templeton	T02992	ST 2 STA T48+00	WATER BRAZELL PND INLET	State Highway Agency
Templeton	T02993	ST2 EB 67+00	WATER BR TROUT BROOK	State Highway Agency
Templeton	T02994	ST2 EB 159+50	WATER TEENY BRK	State Highway Agency
Templeton	T02995	ST 2 EB STA T184+0	WATER SMALL POND OUT	State Highway Agency
Templeton	T02995	ST 2 WB STA T187+0	WATER SMALL POND OUT	State Highway Agency
Templeton	T02998	ST 2A MAIN ST	WATER E TEMPLTN POND	State Highway Agency
Templeton	T02999	HWY GUN CLUB RD	WATER PRTDGEVLE PND OUT	Private
Templeton	T02000	HWY FRNLD SCH RD	WATER BEAVER BROOK	Other State Agencies
Templeton	T02000	HWY FERNALD SC R	WATER BEAVER BROOK	Other State Agencies
Westminster	W28015	HWY MAIN ST	WATER BROOK	Unknown
Westminster	W28024	HWY OAKMOUNT AVE	WATER WHITMAN RIVER	Unknown
Westminster	W28004	HWY FRED SMITH R	WATER PHILLIPS BROOK	Town Agency
Westminster	W28009	HWY POTATO HIL R	WATER PHILLIPS BROOK	Town Agency
Westminster	W28010	HWY WHITMANVIL R	WATER WHITMAN RIVER	Town Agency
Westminster	W28011	HWY WHITMANSVL R	WATER WHITMAN RIVER	Town Agency
Westminster	W28019	HWY DEPOT ROAD	WATER ROUND MEADOW BRK	Town Agency
Westminster	W28020	HWY ELLIS ROAD	WATER UPPER RESVR OUTLET	Town Agency
Westminster	W28030	HWY NARROWS RD	WATER WYMAN POND OUTLET	Town Agency
Westminster	W28003	ST2 A WSTMNSTR R	WATER WHITMAN RIVER	State Highway Agency
Westminster	W28007	ST 12 ASHBURNHM ST	WATER NASHUA RIVER	State Highway Agency
Westminster	W28017	ST 12 ASHBURNHAM S	WATER PHILLIPS BROOK	State Highway Agency
Winchendon	W39029	US202	WATER BEAMANS POND BROOK	Unknown
Winchendon	W39033	ST140 STA 98	WATER BROOK	Unknown
Winchendon	W39003	HWY SPRNG VLLG R	WATER WHITES MILL POND	Town Agency
Winchendon	W39009	HWY BURGESS RD	WATER PRIEST BK BRCH HLL	Town Agency
Winchendon	W39011	HWY N BOSTON RD	WATER MILLERS R BRCH HLL	Town Agency
Winchendon	W39025	HWY GOODNOW RD	WATER PRIEST BK BRCH HLL	Town Agency
Winchendon	W39026	HWY ROBBINS ROAD	WATER ROBBINS BROOK	Town Agency
Winchendon	W39027	HWY HPPY HLLW RD	WATER BROOK	Town Agency
Winchendon	W39031	HWY TEMPLETON RD	WATER BR OTTER RIVER	Town Agency
Winchendon	W39034	HWY MIDDLE RD	WATER PRIEST BK BRCH HLL	Town Agency
Winchendon	W39037	US202 MAPLE ST	WATER WHITNEY PD OUTLET	Town Agency
Winchendon	W39009	BURGESS ROAD	PRIEST BROOK	Corps of Engineers
Winchendon	W39011	NEW BOSTON ROAD	MILLER RIVER	Corps of Engineers

Town	Bridge No.	Over	Under	Owner
Winchendon	W39019	HWY NEW BOSTN RD	WATER BR MILLERS RIVER	Corps of Engineers
Winchendon	W39019	OLD ROUTE 202	MILLERS RIVER	Corps of Engineers
Winchendon	W39025	GOODNOW ROAD	PRIEST BROOK	Corps of Engineers
Winchendon	W39034	MIDDLE ROAD	PRIEST BROOK	Corps of Engineers

Source: MassHighway 2000 ASSHTO ratings.

F. Potentially Harmful Land Use Practices

Although the quantity of pollutants originating from each of the following sources may be very small, their cumulative effects are quite serious. Combined, non-point sources of pollution may kill fish, endanger human health, degrade drinking water supplies, diminish water-based recreation and tourism opportunities, lower real estate values, destroy wildlife habitat, harm aquatic organisms, and reduce the aesthetic values of lakes and streams. Once polluted, the costs of cleanup can be prohibitively expensive. The following list describes some of the most common land uses that can generate nonpoint source contaminants found within the Millers River Watershed. Case examples of many of these nonpoint sources are marked on the Potential Nonpoint Sources Map.

1. Underground Storage Tanks

An underground storage tank system (UST) is a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground. USTs are used to store many toxic fluids, such as gasoline, fuel oils, hazardous wastes, and solvents. Thousands of older tanks are made of steel and are susceptible to corrosion and leaking. Fuels and chemicals leaking from USTs can contaminate soil and groundwater, adversely impacting water supplies for many people. UST leaks may be due to defects in the equipment, improper installation, mechanical failure, or improper maintenance.

Chemicals that dissolve easily in water can travel relatively quickly through soils, posing a threat to groundwater. Such chemicals include benzene, toluene, and the gasoline additive MTBE, which reduces air pollution. Massachusetts is working to find a substitute additive. In the meantime, tough UST and water monitoring efforts are in place to reduce the risk of MTBE contamination.

Federal and State mandates require owners of commercial USTs to upgrade existing tanks to meet their standards.[54] Any new tanks that get installed must meet their specifications. All tanks must be registered, and there are 93 registered tanks in the watershed. Permits are filed with the local Fire departments, and tanks must be inspected every five years. By the end of 1998, all existing single-walled metal tanks were to have been removed, and replaced by safer new fiberglass tanks. Other tanks that are made of unprotected steel or that have steel piping must be upgraded with professionally designed protection systems that inhibit corrosion and they must be tested periodically. Table IV-20 lists the locations of registered underground storage tanks in the Millers River Watershed

Upgrading UST systems is costly, and many owners may have opted not to upgrade. Homeowners are not required to register their home heating oil tanks, many of which are old, bare steel tanks that in all likelihood are leaking. However, tank owners are held liable for damage to drinking water supplies and costs of removing contaminated soil. Education programs on the impacts of leaking tanks, and incentive-driven loan programs with favorable financing could motivate reluctant homeowners to upgrade or replace their leaking tanks. Town bylaws often regulate the construction, installation, operation, and maintenance of USTs, especially in areas of public water supplies, aquifer recharge areas, and their watersheds. Communities that do not have such bylaws should consider adding them.

Table IV-20: Registered Underground Storage Tanks in the Millers River Watershed

Facility Name	Street #	Street	Town
Merrifield Bus Co.	1777	Chestnut Hill Ave	Athol
Frank L. Castine Inc.	1235	Chestnut St	Athol
Hawley'S Service Station	42	Church St	Athol
The L.S. Starrett Co.	121	Crescent St	Athol

[54] The EPA has a website that addresses federal regulation of USTs. The following web address describes the federal role. http://www.epa.gov/swerust1/overview.htm

Table IV-20: Registered Underground Storage Tanks in the Millers River Watershed

Facility Name	Street #	Street	Town
The L.S. Starrett Co.	121	Crescent St	Athol
R.W. Kingsbury #1559	464	Crescent St	Athol
Athol Satellite Office	20	Harrison St	Athol
Citgo	1728	Main	Athol
Mr Mike'S Mobil	2143	Main	Athol
Athol Texaco	223	Main St	Athol
Athol Post Office	242	Main St	Athol
Athol Mobil	243	Main St	Athol
Cumberland Farms Inc. #2143	297	Main St	Athol
Carl's Service Station	1590	Main St	Athol
Athol Memorial Hospital	2033	Main St	Athol
Gerald W. Bartlett	1414	Petersham Rd	Athol
Girardi Dist. Inc.	0	Railrd Pl	Athol
New England Telephone Co.	56	Riverbend St	Athol
Bachelder Oil Co. Inc.	58	Sanders St	Athol
Temple Oil Service Inc.	56	School St	Athol
Old Fashioned Ctry Conv Store	49	South Main St	Athol
Donald L Risatti	49	South Main St	Athol
Country Convenience	49	South Main St	Athol
Joseph A. Mallet	360	South St	Athol
Athol Fuel Service Inc.	575	South St	Athol
DPW Garage	338	Unity Ave	Athol
Erving Paper Mills	0	Arch St	Erving
Town Of Erving	0	River Rd	Erving
Massachusetts DPW	0	Rte 2	Erving
Gardner Texaco	487	Chesnut St	Gardner
Stanley's Garage, Inc	31	City Hall Ave	Gardner
Gardner Fire Dept	70	City Hall Ave	Gardner
Cumberland Farms, Inc	76	City Hall Ave	Gardner
Collier-Keyworth Co - Plant 3	208	Coleman St	Gardner
Mount Wachusett Community College	444	Green St	Gardner
Adolf Vandris & Sons Inc	196	High St	Gardner
Gene's Service Center Inc.	85	Jean St	Gardner
New England Wooden Ware Corp	75	Logan St	Gardner
Getty Oil Prop #1326	221	Main St	Gardner
Ashley Motors, Inc	412	Main St	Gardner
Warehouse	435	Main St	Gardner
Sav-On Heat Co., Leasee	492	Main St	Gardner
People's Fuel & Trucking, Inc	27	Mission St	Gardner
Shell Oil Company	4	Oak St	Gardner
Shell Oil Company	6	Pearson Blvd	Gardner
Mobil Station 06Fy0	17	Pearson Blvd	Gardner
Old Colony (Loc #6783)	19	Pearson Blvd	Gardner
Simplex Time Recorder Company	0	Simplex Plaza	Gardner

Table IV-20: Registered Underground Storage Tanks in the Millers River Watershed

Facility Name	Street #	Street	Town
Shell Oil Co/E.J. Favreau Shell	264	Timpany Blvd	Gardner
Collier-Keyworth Company	1	Tuttle Pl	Gardner
Xtra Mart	45	Union Sq	Gardner
City Of Gardner Public Works Dep.	416	West Broadway	Gardner
Stanley's Garage, Inc	431	West Broadway	Gardner
Stanley's Garage, Inc	442	West Broadway	Gardner
Aspen Transp. Service, Inc	795	West Broadway	Gardner
New England Telephone Co	43	West St	Gardner
West St Servicenter Inc	240	West St	Gardner
Felton Construction Co. Inc.	0	Federal St	Millers Falls
Carroll Bros. Express Inc.	0	Federal St	Millers Falls
Orange Municipal Airport	0	Airport St	Orange
W.T. Bolduc & Sons Inc.	21	Cherry St	Orange
Cumberland Farms Inc.	25	East Main St	Orange
Sunoco Gas Station	107	East Main St	Orange
Pete's Tire Barns Inc.	275	East Main St	Orange
Sunoco Gas Station	312	East Main St	Orange
William Khalil	620	East Main St	Orange
Town Of Orange Hwy. Dept.	25	East River St	Orange
Rodney Hunt Co.	46	Mill St	Orange
Estey's Garage	5	Roche Ave	Orange
Comm. Of Mass. DPW	0	Rte 122	Orange
Sunoco Gas Station	0	Rte 2 & Rte 202	Orange
Getty Property #30622	0	South Main St	Orange
New England Telephone	0	South Main St	Orange
Xtra Mart	272	South Main St	Orange
Orange Texaco	8	West Main St	Orange
Gardner Airport	0	Airport Rd	Templeton
Cumberland Farms Inc #2133	0	Circle St & Elm St	Templeton
Wilson Bus Lines	0	Main St	Templeton
Sewerage Treatment Plant	0	Off Parker St	Templeton
Templeton Waste Treatment Facility	0	Reservoir St	Templeton
Cumberland Farms, Inc	95	Central St	Winchendon
Mathieu Ford Sales Inc	297	Central St	Winchendon
Hwy Garage	0	Glenallen St	Winchendon
New England Telephone Co	0	Grove St	Winchendon
Waterville Plaza Assoc	6	Main St	Winchendon
Bellecraft Wdg. Inc	540	River St	Winchendon
Mass. DPW Maintenance Depot	0	Rte 202	Winchendon
Sherman V. Allen Inc.	348	School St	Winchendon
Arts Auto Repair	110	Spring St	Winchendon
Mr. Mike's Mobil	240	Spring St	Winchendon
Mobil Service Station	246	Spring St	Winchendon

Source: MassGIS, Massachusetts Department of Environmental Protection

Map: Potential Nonpoint Sources

An inventory of all USTs (both registered and unregistered) would help local Boards of Health to identify areas of risk in the watershed. The inventory should include the location, age, material, and condition of the tank. Priority should be given to areas near drinking water supplies, lakes, ponds, and wetlands, and areas where stormwater runoff conditions are intensified by extensive impervious surfaces.

2. Landfills and Illegal Dumping Areas

Active and inactive landfills are often filled with household wastes that contain toxic chemicals such as paints and solvents, cleaning compounds, waste motor oil, pesticides and fertilizers. Though quantities dumped are small to the individual, the cumulative impacts of continuous dumping over many years can be serious for the environment. Rainfall will seep into the landfill, mixing with the chemicals, and eventually leach out to nearby water bodies or the groundwater table.

Many of the older landfills in the state are unlined. These landfills can no longer legally operate since the passage of the Federal Resource Conservation and Recovery Act. They must be closed and capped and groundwater testing and monitoring must be conducted for up to thirty years on properties abutting the landfills. Table IV-6 lists the location and status of the landfills on record with the state as reported in the data library of the MassGIS. Other waste management sites are tracked within the watershed. These are listed in Table IV-21.

Table IV-21: Solid Waste Facilities in the Millers River Watershed

Solid Waste Site	ACRES	Type	Status	Year Opened	Year Closed	Design
Ashburnham Landfill 356 Winchendon Rd (Rte 12), Ashburnham, Ma 01430	5.6	SLF Landfill	Active	1971	1999	Partially Capped, Not Lined
Winchendon Landfill River St, Winchendon, Ma 01475	11.3	SLF Landfill	Active	N/A	1998	Not Capped, Not Lined
Royalston Landfill 6 Town Dump Rd, Royalston, Ma 01368	3.6	SLF Landfill	Active	1913	1998	Not Capped, Not Lined
Gardner Landfill West St (Rte 68), Gardner, Ma 01440	37.1	SLF Landfill	Active	1911	1998	Not Capped, Not Lined
Athol Landfill West Royalston Rd, Athol, Ma 01331	16.3	SLF Landfill	Closed	1955	1993	Capped, Not Lined
Templeton Landfill King Philip's Trail (Rte 202), Templeton, Ma 01436	7.5	SLF Landfill	Closed	N/A	1995	Capped, Not Lined
Hutchinson Dump Hubbardston Rd, Templeton, Ma 01436	2.6	SLF Landfill	Inactive	1974	1975	Not Capped, Not Lined
CJ Mabardy Demolition Landfill 637 River St, Winchendon, Ma 01475	8.1	DEMO Landfill	Inactive	N/A	1986	Unknown Cap, Not Lined
Erving Paper Sludge Landfill Rte 2, Erving, Ma 01344	7.0	SLUDGE Landfill	Active	1977	1998	Not Capped, Not Lined
Mormon Hollow Demo Landfill Mormon Hollow Rd, Wendell, Ma 01379	21.3	DEMO Landfill	Active	1990	1997	Partially Capped, Lined
Wendell Landfill New Salem Rd, Wendell, Ma 01379	2.1	SLF Landfill	Inactive	1960	1990	Not Capped, Not Lined
Orange Landfill Jones St, Orange, Ma 01364	30.4	SLF Landfill	Inactive	N/A	1997	Partially Capped, Not Lined
Drew Demolition Landfill Evergreen St, Orange, Ma 01364	2.1	ILLEGL Other	Inactive	N/A	N/A	Unknown Cap, Not Lined
Erving Landfill Zilinski Rd, Erving, Ma 01344	29.7	SLF Landfill	Inactive	N/A	N/A	Unknown Cap, Not Lined

Source: MassGIS Solid Waste Facility Datalayer, December 1997

One such landfill is located above the Tully River on West Royalston Road two and one half miles upstream from Athol's Zone II wellhead protection area. Though capped and no longer in use, recent monitoring revealed a plume of orange goo leaching out from the landfill traveling down to the Tully River in the vicinity of the aquifer that serves the Tully Well fields and South Street Well. Recent beaver activity caused a rise in surface water levels that backed up to the toe of the landfill, increasing concerns about the leachate plume.

Another controversial site, the Winchendon Landfill, is the subject of local scrutiny. Unfortunately sited on a principal aquifer in the Millers River Watershed, the existing 13-acre municipal sanitary landfill is un-lined and has a plume of chemicals leaching into the groundwater and moving slowly toward the Millers River. Since 1996, residents have complained about odor problems resulting from leaking hydrogen sulfide gases. The DEP investigated the landfill and found numerous operating violations at the site over a five-year period. Subject to the Federal Resource Conservation and Recovery Act, the DEP and the Town determined that the landfill had to be capped and closed. To close the landfill, the town had to increase its height to prevent water from entering the landfill. Over three years, the Town accepted construction and demolition materials at a rate of 295 tons per day. The landfill was finally capped and closed in 1999. Since then several homes were built in the vicinity of the landfill.

The Town has proposed to expand the facility to use the remaining 57 acres set aside for landfill activities. The expansion will occur in three phases and will have a twenty-year life span, with a filling rate of up to 76,000 tons per year of mostly Construction and Demolition material. The new facilities will meet all of the State and Federal regulations for construction of landfills and will make use of state of the art technology to manage leachate and landfill gasses. At regular intervals the liquid leachate will be pumped out and transported to wastewater treatment facilities.

Expansion of the facility would occur to the north and west of the existing site on River Street. The entire area is located in the floodplain of the Millers River and is subject to periodic flooding from the Birch Hill Dam Flood Control Project. The site is also located on the west bank of the Millers River at the confluence with Tarbell Brook. The principal aquifer that underlies the Millers River and Tarbell Brook extends south into Templeton and also underlies the Otter River.

After extensive environmental review, the Executive Office of Environmental Affairs issued approval for the project despite the objectives of neighbors, and local and regional community and environmental groups, and concerns raised by staff of the Montachusett Regional Planning Commission. The project meets a need in the state at a time when the landfill capacity in the state is strained and local communities find they must ship their wastes out of state at great cost both financially and politically. The Winchendon landfill is only one case study, but it points out a very real problem the must be addressed in the future, since so many of the old landfills in the state are situated above rivers and wetlands in environmentally sensitive areas.

Illegal dumping occurs throughout the watershed. Some of these sites are old abandoned dumps dating back fifty to one hundred years. Others are areas that are secluded or hidden, where people dump unwanted refuse such as old appliances, waste motor oil, old tires, and hazardous chemicals. Such sites are typically found along riverbanks at the back edges of commercial and residential properties or on properties with heavy brush vegetation that appear to be abandoned open spaces. These dump sites can pose a serious threat to the groundwater and surface water since they are not monitored and leachate can travel great distances before it is detected.

Boards of Health should try to identify the locations of illegal and abandoned dumpsites to determine how extensive the problem may be in their communities. It may be necessary to evaluate the sites to determine whether they pose a threat of contamination to water supplies.

Methods of reducing the materials dumped in landfills should be explored. Many Massachusetts communities have adopted programs that combine recycling programs with fees charged for waste disposal. An example would be requiring purchase of special trash bags from the municipality for use with non-recyclable material. Some communities encouraging residents to participate in municipal composting programs for yard wastes. Others provide for curbside pick-up of recyclable materials, asking residents to sort the materials they recycle.

Table IV-22: Additional Waste Management Sites* in Millers River Watershed

ID number	Street	Town	Acres
1	Lincoln Avenue	WINCHENDON	10.9
4	Spring Street	WINCHENDON	14.9
6	Hospital Road	TEMPLETON	6.2
7	Reservoir Street	TEMPLETON	37.3
8	Waste Water Road off Mohawk Trail	ERVING	6.8
9	Waste Water Road off Mohawk Trail	ERVING	3.6
10	Maple Avenue	ERVING	1.4
11	West Main Street	ORANGE	6.0
12	Maple Avenue	ERVING	4.2
16	off Fernald School Road	TEMPLETON	3.9
17	WPC Road off River Road	ERVING	3.6
18	WPC Road off River Road	ERVING	2.3
19	South Athol Road	ATHOL	3.1
20	Royalston Road	PHILLIPSTON	7.6
21	South Main Street, Baldwinville	TEMPLETON	17.7
22	Pine Crest Road	ORANGE	8.0
23	Old State Road	ORANGE	10.2
24	Pine Crest Drive	ORANGE	8.5
25	Pine Crest Drive	ORANGE	5.8
30	off Gardner Road, East Templeton	GARDNER	19.5
31	Coburn Avenue	GARDNER	2.2
32	off Gardner Road, East Templeton	TEMPLETON	27.9
33	Baldwinsville Road	PHILLIPSTON	9.2
34	West Broadway	GARDNER	3.4
35	Eagleville Road	ORANGE	2.4
36	Eagleville Road	ORANGE	2.2
37	Kinzer Drive	GARDNER	2.3
38	Timpany Boulevard	GARDNER	5.5
39	Main Street South	TEMPLETON	4.3
40	State Road West	WESTMINSTER	3.8
41	East Broadway	GARDNER	4.8
42	Toby Street	GARDNER	4.9
43	East Chestnut Hill Road	MONTAGUE	1.2
46	Riceville Road	ATHOL	2.3
47	Hubbardston Road	TEMPLETON	12.1
48	Cross Road	TEMPLETON	15.9
49	Monson Turnpike	PETERSHAM	0.5
50	Monson Turnpike	PETERSHAM	0.4
51	South Athol Road	NEW SALEM	1.6
52	South Athol Road	NEW SALEM	3.0

Source: MassGIS. *Includes landfills, auto dumps, and filter beds.

Educational programs aimed at residents and small businesses that describe the content of chemicals typically thrown away, and the impact they have on the environment could significantly reduce the amount of household chemical wastes and motor oils dumped into the landfills. Programs for collection of household hazardous wastes could be incorporated into the recycling programs.

Communities in Millers River Watershed may want to investigate joining regional waste management systems as another alternative to controlling contaminants. Developing such programs for a watershed region should take into consideration the tax base of each community and the cost to provide regional services, as well as the cost to residents for individual waste disposal contracts with private haulers

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3. Hazardous Waste Sites

Improper disposal of hazardous wastes poses a threat to environmental health. Proper management of hazardous wastes must begin with educating the individual making use of hazardous materials as to the nature of the hazard and continue through devising programs for collection of the materials and either reclaiming them or designing sites that are appropriate to their storage or disposal. For individuals, towns can offer programs for the collection of household and small business hazardous wastes, which can then be consolidated by type and disposed of in specially designed incinerators. For large-scale generators of hazardous waste, such programs might prove ineffective.

The Bureau of Waste Prevention of the Department of Environmental Protection regulates numerous facilities throughout the watershed due to their potential for significant environmental impact. Under the Resource Conservation and Recovery Ace (RCRA) program, those who handle hazardous waste, from generation, transport treatment, and storage to disposal must report their activities to state environmental agencies. These sites are carefully monitored and must implement measures to control the flow of pollutants they generate to ensure that they do not exceed their permitted discharges to the environment, or that they properly manage the disposal of the large volumes of waste. Table IV-23 lists the locations and descriptions of the sites regulated by the DEP in the Millers River watershed.

Table IV-23: DEP Regulated Facilities in the Millers River Watershed

Facility ID	Facility Name	Address	Town	DEP Region	AIR*	LQG**	LQTU†
207495	Winchendon Landfill	River St	Winchendon	CERO		Y	
252291	Walmart Inc #2155	677 Timpany Blvd	Gardner	CERO		Y	
130664	S Bent & Brothers	85 Winter St	Gardner	CERO	Y		Y
130669	H&R 1871 Inc	60 Industrial Rowe	Gardner	CERO		Y	Y
130671	Nichols & Stone Co	232 Sherman Street	Gardner	CERO	Y	Y	Y
130661	Simplex Time Recorder Co.	1 Simplex Plaza	Gardner	CERO		Y	
130667	C&W Fabricators	35 Wilkins Rd	Gardner	CERO			Y
221329	Materials Unlimited Inc	252 Baldwinville Rd	Templeton	CERO		Y	
130428	Lilly Industrial Coating	686 Patriots Rd	Templeton	CERO			Y
138896	Seaman Paper Company	PO Box 21, Main St	Templeton	CERO	Y		Y
133374	American Tissue Mills, Inc.	PO Box 25	Templeton	CERO	Y		Y
130149	LS Starrett Company	121 Crescent St.	Athol	CERO		Y	Y
130151	Athol Table Mfg. Co.	151 Harrison St	Athol	CERO	Y		Y
125832	Niagara Cutter Athol, Inc.	273 Main Street	Athol	CERO		Y	
131686	Duvall Plastics Inc	764 S Athol Rd	Athol	CERO			Y
130311	Rodney Hunt Co	46 Mill Street	Orange	WERO	Y	Y	Y
215347	B&G Woodworking Inc	131 W Main St	Orange	WERO			Y
130789	Erving Paper Mills	97 East Main St	Erving	WERO	Y		Y
10672	International Paper	Mill Rd	Erving	WERO	Y		

Source: MassGIS, *Air Operating Permit, **Large Quantity Generator, †Large Quantity Toxic User, CERO = Central Region – Worcester, WERO = Western Region, Springfield

4. Winter Road Maintenance, Salt Storage and Snow Dumping Areas

It is a common practice, both locally and at the state level, to apply salt to the roads and parking lots in winter storms to control ice build-up, keeping roads passable and safer. Winter storm road maintenance is a combination of sand/salt application and plowing. The ratio of sand to salt used in the mixture varies by municipality and with the severity and temperature of each storm event. In colder temperatures more sand is used, to provide traction and to keep roads from developing ice due to salt application. At higher temperatures more salt is used. Typically warmer storms occur in the late winter/early spring, at a period when stormwater runoff and snowmelt are greatest, increasing the potential for high concentrations of salt to infiltrate surface waters and groundwater. Excess sand accumulates on the roadway, blocks storm drains and swales, and increases the sedimentation of streams and rivers especially at culverts and stormwater discharge pipes.

Many communities in Massachusetts have designated areas where salt application is significantly reduced or curtailed, in response to concerns about groundwater and well water contamination. The State has also designated selected areas. Communities in Millers River watershed may have adopted such areas, as well. These areas should be documented and mapped. The mapping should also delineate areas that are likely to be significantly impacted by salt application. Wetland areas, small streams, and slow-moving shallow rivers that receive stormwater runoff from roads should all be identified and monitored for salinity and sedimentation impacts.

Salt Storage facilities have significant potential for groundwater contamination. Since salt is highly water soluble, humidity and water leaks can cause stored salt to dissolve and be washed into the ground. Siting of salt storage facilities near water supplies, wells, floodplains, and aquifers is ill-advised, and should be discouraged or prohibited. Storage facilities should be designed to minimize contact with the ground and exposure to the weather.

Snow removal practices can be a direct source of salt, sediment, and other road related contaminants to rivers, streams and lakes. Snow dumping can result in a prolonged period of salt and contaminant release, since large snow piles take a while to melt. Snow removal contractors should try to locate snow piles away from sensitive areas. Where snow is collected on-site at large parking lots, it should be piled away from the storm drainage system. Ideally the storm drainage system should incorporate measures for removal of sediments and road chemicals before release to the ground or surface waters. Lot owners should be educated as to the impacts of snow storage or dumping. Dumping of snow over the edge of river embankments should be prohibited.

Pursuant to M.G.L. Chapter 85 Section 7A the storage of deicing materials within a groundwater supply or two hundred feet of a water resource is prohibited unless confined to a solid framed shed to ensure against groundwater leaching. Further, this regulation may determine the place where such chemicals are applied. This regulation applies to all highway garages or persons who use more than 1 ton of deicing chemicals within a twelve-month period. These persons must also report their usage/amounts per road section of deicing chemicals to the MA DEP.

MRPC surveyed the local Departments of Public Works to obtain the locations of the sand/salt storage barns. Most of the larger salt piles are located on DPW or MHD properties. The sand/salt ratios used by local Departments of Public Works and the MHD should be inventoried. If practical, these departments may want to consider the use of alternative compounds that have less impact on the environment. Existing facilities should be evaluated to determine their proximity to water supplies and other sensitive water resources, and their effectiveness at containing the salt compounds and preventing exposure to water. The locations of all the private salt storage facilities in the watershed have not been identified. Table IV-24 lists the results of the phone survey.

Table IV-24: Phone Survey of Local Departments of Public Works

Municipality	What is (are) the location of your public salt/sand storage barn(s)?	Are they housed in salt sheds?	What is the sand/salt ratio used by the department?	How is the sand/salt ratio determined?	Are there any low-salt areas in town?	Does the town haul away any snow during heavy storms?	Where is the snow dumped or stockpiled?	Do you know of any businesses that have their snow hauled away?
Ashburnham	17 Central St.	Yes	3:1		Near Reservoir	No		
Athol	Petersham Rd.	Yes	240/mile	Set Standard	Rt 32 at Rt 122. Rt 2A from Rt 32 to Templeton TL	No		
Erving	Maple Ave	Yes	10 lbs to 18 Yds.	Town Well Protection	The entire town.	No		
Gardner	At DPW	Salt yes, Sand no	3:1	Temperature and Forecast	Around the Watershed	Yes	Behind DPW	Many, unsure of destination
Hubbardston	At DPW	Yes	Varies	Weather	No	No		
Orange	526 East River St.	Yes	Triax 18-20, 3 yds Salt	Weather	No	Yes	Near Salt Shed	
Phillipston	1/4 mile from Common	Yes	5:1 6:1 3:1	Time of Year	No	No		
Royalston	20 Winchendon Rd.	Yes	3:1	Weather	Royalston Commons Area. Well Areas.	No		
Templeton	381 Baldwinville Rd.	Yes		Weather				
Warwick	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wendell	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Westminster	2 Oakmont Ave.	Yes	1:1	Weather	South St.	No		
Winchendon	Glenallen St.	Yes	5:1	Road Conditions	No	Yes	Off of Webster St.	

Source: MRPC Telephone Survey, January 2002

5. Vehicle Maintenance Yards and Auto Salvage and Junkyards

Vehicle maintenance areas, auto body and auto repair shops collect waste engine oils, lubricants, solvents, antifreeze, paints and other chemicals that are used in the routine maintenance of motor vehicles. Most of these places are regulated by the Resource Conservation and Recovery Act program and are probably in compliance with their permits. However, these chemicals can leak or be spilled onto shop floors and maintenance yards, where they can be exposed to stormwater runoff or permeable ground.

Numerous active and abandoned junkyards exist in the watershed, as well. At these sites junk autos and machinery are stored outside and uncovered, often on unpaved lots. Many of these businesses may be operating under general stormwater permits issued by the U.S. EPA. These permits are required if stormwater runoff from the salvage yard impacts wetlands or surface waters. At active sites it is important that all fuels and fluids be removed from the vehicles and machines and properly disposed of before they are stored outside. The permitting process requires the development of best management practices to ensure proper treatment and disposal of the pollutants. At abandoned sites, the properties should be evaluated to determine if the groundwater is at risk for contamination from past use. Table IV-25 lists the municipal DPW maintenance facilities in the watershed, and Table IV-26 lists the privately owned sites.

Table IV-25: Local DPW Vehicle Maintenance Yards

Municipality	Location
Ashburnham	17 Central St.
Athol	Not available
Erving	River Rd.
Gardner	At DPW 416 W Broadway
Hubbardston	At DPW
Orange	526 East River
Phillipston	In Common
Royalston	20 Winchendon Rd.
Templeton	381 Baldwinville Rd.
Warwick	Not available
Wendell	Not available
Westminster	2 Oakmont Ave.
Winchendon	Glenallen St.

Source: Municipal Departments of Public Works

Table IV-26: Vehicle Maintenance Areas in the Millers River Watershed

Facility Name	Facility Address	Town	State (ZIP)	EPA Facility ID	Status
Alan's Auto Body	Winchendon Rd Rte 12	Ashburnham	MA 01430	10367606	
Crichtons Fun Vehicles Inc	485 Winchendon Rd	Ashburnham	MA 01430	MAD055744213	
B A P Auto Body Div	201 Daniel Shay Hwy	Athol	MA 01331	10425908	C. E. Generator
Bosworth Auto Repair	375 Exchange St	Athol	MA 01331	10520664	C. E. Generator
Carl's Service Station	1590 Main St	Athol	MA 01331	MAD982542870	
Clarks Garage	29 Church St	Athol	MA 01331	10529438	C. E. Generator
Dales Auto Body	Bickford Dr	Athol	MA 01331	10367852	C. E. Generator
Merrifield E H Bus Co Inc	1777 Chestnut Hill Ave	Athol	MA 01331	10525694	C. E. Generator
Mobil Oil Corp Ss 98Atn	2298 Main St	Athol	MA 01331	MA0001136563	
Piragis Boats & Motors	Daniel Shays Hwy	Athol	MA 01331	MAD019156777	
Roberts Fords Sales Inc	1665 Main St	Athol	MA 01331	MAD019156835	
Stan's Auto Body	963 Main St	Athol	MA 01331	MAD037688736	
Tedford Chrysler Plymouth Inc	156 Daniel Shays Hwy	Athol	MA 01331	MAD041510744	
Henrys Auto Body	N Main St	East Templeton	MA 01438	MAD005255187	Small Generator
Ashley Motors Inc	412 Main St	Gardner	MA 01440	MAD139381172	C. E. Generator
Babs Auto Body	87 Pine St	Gardner	MA 01440	MAD075347187	C. E. Generator
Bruces Auto Service	437 Main St	Gardner	MA 01440	MAD981073992	C. E. Generator
C & M Express Inc	766 W Broadway	Gardner	MA 01440	MAD981892631	
Custom Auto Body & Sales	179 West St	Gardner	MA 01440	MAD059017525	C. E. Generator
Freds Auto Body	638 Summer St	Gardner	MA 01440	MAD030815419	C. E. Generator
Gardner City Of	416 W Broadway	Gardner	MA 01440	10421282	C. E. Generator
Gardner Town Of Fire Dept	70 City Hall Ave	Gardner	MA 01440	MAD985267780	C. E. Generator
Genes Service Center Inc	85 Jean St	Gardner	MA 01440	MAD982190506	C. E. Generator
Jamco Ventures Inc	15 Donlan St	Gardner	MA 01440	MA0001040500	
Js Service Station Of Gardner Inc	411 Parker St	Gardner	MA 01440	MAD981072408	
Kangas Garage Inc	400 Lowell St	Gardner	MA 01440	MAD981066376	C. E. Generator
Manca Bros Inc	91 Fredette St	Gardner	MA 01440	MAD985266063	
Midas Muffler	18 Dyer St	Gardner	MA 01440	MAD982753105	
Millers Garage	207 E Broadway	Gardner	MA 01440	10423468	C. E. Generator
New England Furniture Express Inc	199-203 E Broadway	Gardner	MA 01440	MAD094849668	C. E. Generator
Rahaim Auto Body	549 W Broadway	Gardner	MA 01440	10421076	C. E. Generator
Salvadore Chev Olds Geo	442 W Broadway	Gardner	MA 01440	MAD019377845	Small Generator
Stanley Motor Sales Inc	31 City Hall Ave	Gardner	MA 01440	MAD065785149	
Stewart Ken Transmission Co Inc	549 W Broadway	Gardner	MA 01440	MA0001892314	
T J & Sons Auto Repair	Lower Parker St	Gardner	MA 01440	MAD981888118	Small Generator
West Street Service Center Inc	240 West St	Gardner	MA 01440	MAD019378157	
Al's Quickie Lube	187 Daniel Shays Hwy	Orange	MA 01364	10425036	C. E. Generator

Facility Name	Facility Address	Town	State (ZIP)	EPA Facility ID	Status
Careys Sunoco	107 E Main St	Orange	MA 01364	MAD985279306	
City Engines Inc	Orange Municipal Air-port	Orange	MA 01364	MAD037682994	
Jims Auto	38 Smith Ave	Orange	MA 01364	10452324	C. E. Generator
Ma Dept Of Environment Mgmt	Rfd 1 Rte 2a	Orange	MA 01364	MAD985269265	
Mckenneys Service Sta	300 S Main St	Orange	MA 01364	10444288	C. E. Generator
Orange Auto Body	164 E Main St	Orange	MA 01364	10535700	C. E. Generator
Porter Transportation Co Inc	61 Tully Rd	Orange	MA 01364	10421184	C. E. Generator
Sandri A R Inc	Hayden St	Orange	MA 01364	MAD985279363	
Temples Garage	312 E Main St	Orange	MA 01364	10459080	C. E. Generator
Whitmore Auto Wrecking	439 E River St	Orange	MA 01364	MAD019555747	
Sunoco Service Sta	207 E Broadway Cor Maynard St	South Gard-ner	MA 01440	MA0000250225	
Chicks Auto Body	Gardener Rd	Templeton	MA 01438	MAD081579567	
Cosentino Salvage	Gardener Rd	Templeton	MA 01438		
Hooks Auto Body	Rte 2a Athol Rd	Templeton	MA 01468	10372850	C. E. Generator
Tolman Construction Service	1 Old Royalston Rd	Templeton	MA 01436	MAD982191116	
Vallieres Auto Repair	Central St Box 86	Templeton	MA 01436	MAD982194714	C. E. Generator
Wilson Bus Lines Inc	Main St	Templeton	MA 01438	MAD019338250	
Ma Correctional Institution War-wick	233 Richmond Rd	Warwick	MA 01384	MAD982194359	
Hilltop Auto Repairs & Wrecking	Wickett Pond Rd	Wendell	MA 01379	MAD982193211	
Mormon Hollow Auto Salvage	Mormon Hollow Rd	Wendell	MA 01379	10381662	C. E. Generator
Pierce R E Auto Parts	Stone Road at Mountain Road	Wendell	MA 01380	MAD985268606	
Gale Chevrolet Buick Inc	67 Central St	Winchendon	MA 01475	MAD114356066	
L T Auto Body	305 Brown St	Winchendon	MA 01475	10424782	C. E. Generator
Mathieu Ford Sales Inc	297 Central St	Winchendon	MA 01475	MAD019718352	C. E. Generator
Mikes Auto Body	46 Pond St	Winchendon	MA 01475	MAD981068323	C. E. Generator
New England Automotive	1 Beech St	Winchendon	MA 01475	MAD981212673	C. E. Generator
Putnam Chevrolet Buick Inc	67 Central St	Winchendon	MA 01475	MAD114356066	
Speedway Petroleum Co Inc	344 School St Rte 12	Winchendon	MA 01475	MAD985318146	
Toy Town Auto Body & Welding Corp	800 Spring St	Winchendon	MA 01475	MAD019718634	C. E. Generator

Source: MassGIS datalayer from the Department of Environmental Protection Bureau of Waste Prevention Major Facilities, August 2000.

6. Septic Systems

Ashburnham, Athol, Erving, Gardner, Montague, Northfield, Orange, Royalston, Templeton and Winchendon all rely on public sewage systems as well as private septic tanks. The Towns of Hubbardston, Warwick, Wendell, and Westminster rely exclusively on individual, on-site septic tanks for wastewater disposal. Faulty or failing septic systems can yield serious health risks. If not maintained properly, septic systems can degrade the environment and destroy drinking water supplies by depositing contaminants into groundwater, streams, and lakes. Also, failing septic systems are very expensive to repair and reduce the value of property.

To assist homeowners finance septic system repairs or replacements, the MRPC has tapped into a Department of Environmental Protection program that offers grants to low and moderate-income residents. Through the program, septic systems have been installed and/or planned for households in Ashburnham, Phillipston and Royalston to bring them into compliance with the State's Title V legislation. In addition, the federal and state governments offer several forms of financial assistance to individual homeowners through the Homeowner Septic Loan Program, Rural Housing Division Home Improvement Loans, and the Massachusetts Housing Finance Agency Homeowner Septic Repair Program.

7. On-site Sewage Systems

Nutrients and pathogens can seep into groundwater and surface water if the systems are improperly sited, installed, or maintained. Discharges from failing onsite sewage treatment facility are a primary source of fecal contamination containing pathogenic organisms (bacteria, viruses, and protozoa). Nutrients (nitrogen and phosphorus) can also be problematic. The soil around the system removes the nutrients, and the degree of effluent remediation depends on soil texture and chemistry, the depth of the unsaturated zone, and the distance of the system from receiving waters. Seepage from onsite systems can infiltrate sources of drinking water, cause health risks for swimmers and consumers of contaminated shellfish, and disrupt aquatic ecosystems by poisoning aquatic organisms and causing excessive growth of aquatic vegetation.

8. Road Runoff and Combined Sewer Overflows

Nutrients, sediments, pathogens, and toxins are picked up from yards and streets and enter surface and groundwater, in some cases mixed with untreated sewage from combined sewers. In older, larger cities, the same pipe often carries stormwater and sewage flow. During storms, the pipes can't handle the high-volume flows. Consequently, untreated wastewater flows directly into rivers. In Erving, the Millers Falls Wastewater Treatment Plant has a Combined Sewer Overflow system (MA0101516).

Urban development changes the hydrology of an area. Where natural vegetation and soil structure once allowed the gradual absorption and filtering of rain and snowmelt, the impervious surfaces of buildings and parking lots speed the delivery of both water and pollutants to our waterways. Pollutants are transported by rain and snowmelt into storm drains that flush the wastes into rivers and lakes. In developed areas, surface runoff is accelerated by changes in slope.

Ordinary citizens contribute to polluted runoff in many ways, often without realizing it. Car washing and maintenance can release salts, anti-freeze, and oils onto the pavement and then into storm drains and ditches. Pollutants from vehicle exhaust and backyard burning eventually settle to the ground and are washed into adjacent waterbodies during the next storm event. Households with lawns or gardens use more chemicals on a given area than commercial growers. Excess amounts of these compounds find their way into the soil, ground water and adjacent surface waters.

Under the guidelines of the Clean Water Act, the NPDES program has developed a two-phase program for storm water management. Phase 1 requires permitting for separate stormwater systems serving communities with populations over 100,000, and for industrial and construction activity. Phase II covers urban areas with a population density exceeding 1000 persons per square mile of land area, smaller construction sites, and commercial and residential activities. Though the EPA tracks NPDES permits and makes the data available through it Envirofacts Website, information specific to stormwater permits was not readily available.

Industrial and commercial businesses contribute pollutants to stormwater runoff through accidental spills and leaks, and through use and discharge of potentially toxic compounds. Activities that take place at industrial facilities, such as material handling and storage, are often exposed to storm water. The runoff from these activities discharges industrial pollutants into nearby storm sewer systems and water bodies. This may adversely impact water quality. Many industries are required by their liquid waste management permits to collect, monitor, or treat stormwater. However, uncontrolled runoff from some industries remains a significant problem and efforts to replace harmful compounds with environmentally safe, yet effective, alternatives can be challenging.[55]

Operators of large and small construction activities must obtain coverage under an NPDES construction storm water permit.

A large construction activity is one that:

- Will disturb five acres or greater; or

[55] US Environmental Protection Agency Office of Wastewater Management Storm water Program Website, http://cfpub.epa.gov/npdes/stormwater/swphase1.cfm?program_id=6

- Will disturb less than five acres but is part of a larger common plan of development or sale whose total land disturbing activities total five acres or greater (or is designated by the NPDES permitting authority); and
- Will discharge storm water runoff from the construction site to a municipal separate storm sewer system (MS4) or waters of the United States.

A small construction activity is one that:

- Will disturb one or more and less than five acres of land; or
- Will disturb less than one acre but is part of a larger common plan of development or sale whose total land disturbing activities total between one and five acres (or is designated by the NPDES permitting authority); and
- Will discharge storm water runoff from the construction site to an MS4 or waters of the United States.

Under the NPDES storm water program, operators of large, medium and regulated small municipal separate storm sewer systems (MS4s) require authorization to discharge pollutants under an NPDES permit. Medium and large MS4 operators are required to submit comprehensive permit applications and are issued individual permits. Regulated small MS4 operators have the option of choosing to be covered by an individual permit, a general permit, or a modification of an existing Phase I MS4's individual permit.

Highway stormwater runoff combines the worst of industrial and residential runoff with erosion and sedimentation from roads and road salt. Many towns try to manage sedimentation through street sweeping programs. Table IV-27 lists the towns in the watershed with street sweeping programs according to a telephone survey of local departments of public works. The survey did not reveal during what season the street sweeping occurred.

Table IV-27: Millers River Watershed Street Sweeping

Town	Street Sweeping Schedule
Ashburnham	Once Yearly
Athol	Not swept
Erving	Once Yearly
Gardner	Twice Yearly
Hubbardston	Hired Out Schedule undetermined
Orange	Hired Out Once Yearly
Phillipston	Once Yearly
Royalston	Once Yearly
Templeton	Twice Yearly
Warwick	N/A
Wendell	N/A
Westminster	Once Yearly
Winchendon	Once Yearly

Source: MRPC DPW Telephone Survey, January 2002

9. Sand and Gravel Operations

The mining of resources such as sand and gravel for product or construction purposes can have water quality and aquatic habitat impacts. Silt and sediment can be eroded into water resources if proper controls are not established. Sorting, washing, and other processing facilities of extracted resources and disposal of waste products may affect nearby waterways. Large resource extraction operations can result in severe modification to groundwater hydraulics. This is evidenced by wetlands being drained up gradient of the extraction.

The Sand and gravel operations in the Millers River Watershed were identified using the land use datalayer from MassGIS. All of the sand and gravel operations are located in areas where sand deposits exceed 50 feet in

depth. These permeable soils coincide with a number of recharge areas for aquifers and the courses of the Otter River and Millers River. The course sandy soils are prone to erosion and are sensitive to the use of heavy processing equipment. Care must be taken that vehicle maintenance solvents and fuels are prevented from permeating the soils to groundwater or washing into nearby surface waters. Abandoned sites should be checked for erosion and leaking fuel storage tanks

A total of five sand and gravel companies have listings in the Verizon Yellow Pages. However, there are thirty-eight sites identified as sand, gravel, or mining in the land use datalayer from MassGIS. Some of these may be sites owned by the five listed companies, some may be abandoned, and others may have been converted to other purposes since the sand and gravel was excavated from the sites. Several of the sites are located in close proximity to the Millers, Otter, and Tully Rivers. These sites should be evaluated to ensure that the waters are protected from erosion and sedimentation, as well as potential groundwater or surface water contamination.

Table IV-28: Active Sand and Gravel Companies

Company Name	Address	Town
W. J. Graves Construction Company	192 Depot Road	Templeton
C. J. Mabardy Washed Sand and Gravel	River Street	Winchendon
E. W. Sykes General Contractors		South Athol
G & S Lyman	76 Chase Street	Orange
Porter Transportation Company	61 Tully Road	Orange

Source: Verizon Yellow Pages

10. Significant Streambank Erosion

When a disturbance to the watershed occurs through small incremental encroachments to the floodplain of the stream eventually there are changes in the discharge, which ultimately changes the streams morphology. Hydrological alterations – culverts, dams (including small low head dams) stream channelization and other anthropogenic disturbances can have negative effects upon local water resources. Elimination of high percentages of vegetated areas, low-lying wetlands and non-paved areas has led to a change in the volume and the velocity at which water and sediment enter into streams. Changes in the hydrology and sediment load of Massachusetts streams and rivers have led to increased rates of flooding and erosion as well as diminishing wildlife habitat that rely upon clean properly functioning streams (ERI, 1996; Rosgen, 1996; Rosenberg, 2000).

For purposes of this study, observation of stream bank erosion in the Millers River Watershed is limited to the efforts of the Otter and Tully River Stream Teams and the windshield surveys conducted by the MRPC and FRCOG. These cases are documented later in Section V – Stream Team Nonpoint Source Assessments. A review of the data collected for the Stream Stability and Scour Assessment by the USGS and MHD would help to identify more cases of significant streambank erosion, however, such a review is outside the scope of this project. Data collected for each bridge site includes information on geomorphic and hydraulic characteristics of the streams, information on the road crossing the stream, and information on the condition of the stream channel and its banks.

11. Forestry Cutting Operations

Forest cutting procedures impact water quality through removal of the trees and other vegetation, which changes the hydrologic regime, increasing the velocity of runoff and the potential for erosion. Impacts generally result from soil erosion during road building. Skidding activities, poorly constructed water bars, and poorly constructed stream crossings may lead to sediment-laden runoff entering water resources. The Department of Environmental Management requires the landowner of large scale logging sites (those likely to yield greater than 25,000 board feet) to file a cutting plan and obtain a permit from DEM. The cutting plan must include Best Management Practices, as described under M.G.L Chapter 132-the Massachusetts Forest Cutting Practices Act. If the site impacts lands protected under the Wetlands Protection Act, the plan must also be filed with the local Conservation Commission to receive an Order of Conditions.

The DEM lists a total of 22,812 acres of forestland under certified forest management plans, as of September 24, 2002. All of this acreage is listed as either Chapter 61 or Chapter 61A land. Only seven towns were included in their lists at the time. Table IV-29 lists the communities with forest management plan, and the acreage of land and number of sites under these plans.

Table IV-29: Department of Environmental Management Forest Management Plan Certified Acres

	Acreage by Plan Type and Number of Sites													
	01 Ch 61 Certification		02 Ch 61 Recertification		03- Ch 61 Amended		04 Ch 61A Certification		05 Ch 61A Recertification		06 Ch 61 Amended		Total Acres/Sites	
Athol	139.5	4	1,866.3	22	299.4	2	42.7	1					**2,376.9**	**29**
Gardner	112.6	2											**114.6**	**2**
Orange	1,272.4	20	2,345.2	26	645.4	9	1,514.3	14					**5,846.3**	**69**
Phillipston	346.1	6	663.3	6									**1,021.4**	**12**
Royalston	1,037.1	24	3,820.3	42	268.6	2	612.4	7			221.3	2	**6,036.7**	**77**
Templeton	252.0	6	398.4	8					137.4	2	0.0	1	**804.8**	**17**
Winchendon	1,421.3	15	3,454.6	28	1,375.8	16	299.0	5					**6,614.7**	**64**
Total	**4,581.1**	**77**	**12,548.1**	**132**	**2,589.2**	**29**	**2,468.3**	**27**	**137.4**	**2**	**221.3**	**3**	**22,812.3**	**270**

Source: Department of Environmental Management, Forestry Service, as of September 24, 2001

There may be many logging operations throughout the watershed that do not meet the threshold that requires the submission of cutting plans. Landowners and logging operators of these sites should be encouraged to engage in the same BMP's that are required of the large operations. The Department of Environmental Protection Office of Watershed Management publishes the Massachusetts Forestry Best Management Practices Manual, a booklet describing seventeen BMP's. The practices describe site erosion control specifications for access roads, skid trails, stream crossings, and filter and buffer strips with the intent of minimizing the overland speed and volume of runoff water.

12. Agricultural Practices

Fertilizers, manure, pathogens, pesticides, and sediments can enter surface and groundwater if agricultural practices are improperly managed. The most worrisome contaminants are ammonia, nutrients, pathogens, and sediments. Ammonia is toxic to fish, while nutrients can impair water quality. Manure is a significant source of nitrogen, phosphorus, biochemical oxygen demand, and pathogens, including those responsible for waterborne diseases. Proper management is required to avoid adverse effects to water supplies and human health. When too much manure and chemical fertilizer are spread onto fields for crop enhancement, excess nitrogen leaches into groundwater or enters adjacent streams. Timing of manure spreading and other management practices can affect the severity of the impact. If spread in the late fall and early winter, when the plants' nutritional needs are the lowest, winter precipitation can carry ammonia, pathogens, and oxygen-demanding materials into waterbodies.

Pesticides can contaminate waterbodies by several routes, including spillage, improper storage, application too near or into ditches and streams, leaching from soils, or washed away in runoff. Integrated pest management is an ecological approach to pest management where all available control technologies are consolidated into a unified program aimed at preventing economic damage and adverse effects to human health and the environment.

As discussed in the section on land use, only a small percentage of the land area is used for agricultural purposes. Only 3,271 acres are used for cropland, and only 2,760 acres are used for pasture. An effort should be made to identify the agricultural landowners and determine whether they operate large-scale animal feeding operations or engage in use of pesticides. An educational program targeting these landowners could enhance their awareness of Agricultural Best Management Practices. Proper application of fertilizers and pesticides should prevent "overdosing" of the affected land area. Landowners can also be encouraged to seek alternative methods (chemical free) of pest control and fertilization. Some attempt should be made to quantify the impact

of agricultural practices in this watershed, however, since the percent of the land area in agricultural uses is so small. Pollution impacts may be slight.

13. Golf Courses

Golf course construction eliminates tree coverage and alters drainage systems, as well as exposing large amounts of soil. These activities can cause erosion and sedimentation of nearby waters. Once constructed, golf courses are maintained with the use of pesticides and fertilizers to develop the grass fairways and greens. Care should be taken when using pesticides and fertilizers to ensure that they do not adversely impact aquifers, recharge areas, wetlands, private wells, and flood prone areas. Vegetation management should be done in a manner that guards against erosion.

The Millers River Watershed has five golf courses, as listed below:

Table IV-30: Golf Courses in the Millers River Watershed

Subwatershed	Golf_name	Address	Town	Waterbodies Nearby	Acres
Lake Rohunta	Petersham Country Club	240 North Main Street	Petersham		19.4
Lake Rohunta	Ellinwood Country Club	1928 Pleasant Street	Athol	Ellinwood Brook, Lake Ellis, Flood Plain, Wetland	116.2
Otter River	Templewood Golf Course	160 Brooks Road	Templeton	Otter River	46.7
Otter River	Gardner Municipal Golf Course	152 Eaton Street	Gardner	Crystal Lake	108.6
Upper and Middle Millers River	Winchendon Country Club Professional	172 Ash Street	Winchendon	Millers River and Whitney Pond	74.4

Source: MassGIS Land Use Datalayer, 1999

14. Airports

The Millers River Watershed has two airports, both located adjacent to rivers. The Gardner Airport, located over the border in Templeton is adjacent to the Otter River. Recently, the City of Gardner acquired three parcels of land on the Otter River adjacent to a wetland that is formed by the confluence of Templeton Brook and Hubbardston Brook with the Otter River. Access to these new conservation parcels is afforded by the airport access road. The Orange Municipal Airport is located in South Orange on East River Street, off of Daniel Shays Highway, and adjacent to Shingle Swamp. A small brook that feeds the Millers River drains this swamp.

Airports can be a significant source of NPS pollution due to the large amount of impervious surfaces and the maintenance facilities for aircraft and other airport vehicles. These facilities generate potential contaminants such as waste oil, gasoline, hydraulic fluid, solvents, battery acids, and deicing compounds. Vegetation control practices often include the use of herbicides and pesticides to maintain an obstruction free runway. Due to the proximity of these two airports to the Otter River, Millers River and associated wetlands, the same care that must be taken at automotive repair facilities and major transportation centers should be applied in the management of chemical storage and waste disposal at airports.

15. Land Development

Construction projects and urban development can disrupt natural water flows, generate sediments, toxins, pathogens, and create opportunities for numerous other non-point sources of water pollution. Land development directly increases NPS pollution through erosion and sedimentation from land clearing and excavation. Expanding development provides opportunities for numerous non-point sources of water pollution, such as construction site runoff, storm drains, spills and leaks, atmospheric deposition, and on-site sewage systems. In its initial stages, land development can result in loss of green space, decreased pervious surface area, diversion and channelization of streams, destruction of aquatic habitat, and removal of riparian vegetation- all elements of natural systems that buffer, filter, and purify water and provide cover and food for fish. Land clearing and excavation can cause extensive erosion. When land development is complete, impermeable roads, sidewalks, driveways, parking lots, and rooftops dramatically increase the volume and rate of surface runoff, creating the potential for more severe erosion and flooding.

Some of the more significant impacts caused by poor land development practices include increased water treatment costs, reduced recharge of aquifers, interference with navigation and recreation, flood damage and erosion, and destruction of aquatic habitat for fish and wildlife. Construction activities can also introduce pollutants such as phosphorus, nitrogen, petroleum products, organic chemicals, metals and sediments, which eventually find their way into adjacent waterbodies.

Another effect associated with expanding urbanization is an increased potential for hydrocarbon spills and leaks into waterbodies, ranging form the very large (a tanker spill) to the very small (dripping gasoline during vehicle and boat refueling). Chemicals typically spilled (accidentally or deliberately) into storm drains from residential or commercial sources include paint thinners, wood preservatives, engine oil, antifreeze, pesticides, herbicides, and household cleaners. Spills of chlorinated drinking water into small streams can cause major fish kills.

Other sources of contaminants associated with urban land developments include runoff from large impervious areas (ie. parking lots), sewage leaks and spills from sewer line breaks and illegal residential sewer connections to storm drains, oil from automobile maintenance and leaky underground storage tanks, sump pump discharges, spills from transportation accidents, chlorinated water from urban fire fighting, water main flushing and breaks, dewatering of muddy construction sites, and leachates from landfills and sites contaminated with hazardous materials.

G. Pollutant Loading Analysis

Locating and measuring nonpoint source pollution can be a difficult and daunting task, but statistical models can offer a quick approach to analyzing general conditions in the watershed using available land use data and reasonable measures for typical nonpoint source pollutants such as nitrogen, phosphorus, and suspended solids. The impact of urbanization on river systems resulting from rendering land surfaces impervious to water absorption can also be estimated using measures of the percent of land uses that are impervious to water. The model can help to assess and prioritize sub-basins in the watershed that are at greater risk. The assessments can serve as a means of targeting efforts for further study and mitigation.

Michael L. Stulzfus, M.S created one such model for the Millers River Watershed. The model uses a geographic information system (GIS) and a methodology developed by Dr. Brian Brodeur, Senior GIS Analyst at the Massachusetts Department of Environmental Protection. The demonstration project offers a method of determining the anticipated amount of nitrogen, phosphorus, and suspended solids likely to be found on the land uses on an annual basis. The project also estimated the percent of impervious surfaces by land use in the watershed.

Nitrogen and phosphorus are nutrients essential to plant life. They are found in stormwater runoff and can lead to eutrophication (excessive nutrient enrichment) in waterbodies when quantities exist in excess of ecosystem needs. While sediments are not toxic, they can carry pollutants and trace metals. They also make the water murky and reduce light penetration. Sediments are the result of erosion due to storm events, land use practices, soil and geologic conditions and urban runoff.

Water quality is sensitive to substances such as oil, gas, sediments and road salt, contained in water runoff from storm events. As the percent of impervious surface increases, the ability of the remaining soil to filter pollutants and retain water becomes strained during large storm events. Impervious cover also results in higher flood peaks as more water is forced to run off, and longer low-flow periods due to an inability to recharge groundwater.

The GIS model determines the annual pollutant loads per acre by multiplying a set of runoff coefficients for the pollutants[56] by the acreage of each land use within a sub-basin, then dividing the result by the total area of the sub-basin, yielding load in pounds per acre per year. The model also determines the impact of impervious surfaces by estimating the impervious acreage of each land use in the watershed[57]. Table IV-31 lists the coefficients for nutrient loads and impervious surfaces that were applied to the Otter River Watershed acreage. Impervious surface coefficients were developed for the Assabet River Watershed. A more accurate assessment would be achieved by using coefficients developed for the Millers River watershed land uses, but these are not available.

Impervious cover impact categories, as defined in the Rapid Watershed Assessment Handbook (Center for Watershed Protection, 1998), were used to assess and prioritize sub-basins and subwatersheds for remediation activities.

1) Sensitive streams (0-10% impervious cover) the stream has high water quality, stable channels, good habitat, and diverse communities of fish and aquatic insects. The hydrologic regime is consistent with natural conditions. Species sensitive to pollution are within normal abundance ranges.

2) Impacted (11-25% impervious cover) – Streams begin to show signs of degradation due to watershed development. Erosion and stream channel widening become evident. Sensitive fish and aquatic insects begin to drop in overall numbers. Overall water quality is classified as fair or good.

3) Non-Supporting streams (impervious cover exceeds 25%) – In non-supporting streams, channels become highly unstable, severe widening occurs along many stream reaches, down-cutting and streambank erosion are chronic problems. The biological quality of non-supporting streams is relatively poor

[56] The EPA's Nationwide Urban Runoff Program provided pollutant coefficients.
[57] Coefficients for impervious surfaces by land use were developed for the Assabet River Watershed.

with only pollutant tolerant species existing within its reaches. Water quality is considered fair to poor.

Table IV-31: Land Use Coefficients for Nutrients, Suspended Solids, and Impervious Surfaces

	Coefficients			
Land Use	**Nitrogen**	**Phosphorus**	**Suspended Solids**	**Impervious Surfaces**
Cropland	3.35	0.647	411	0.01
Pasture	3.35	0.647	104	0.01
Orchard/Nursery	0		0	0.01
Forestland	2.59	0.095	21	0.01
Forested Wetlands Non-Forested Wetland	3.99	0.20	47	0.01
Mining (Gravel, etc.)	1.14	0.057	13	0.01
Open Land	1.14	0.057	13	0.01
Recreation	4.47	0.895	266	0.02
Spectator	16.10	1.25	40	
Water Recreation	1.14	0.895	13	0.02
Residential Multi	15.40	3.09	732	0.80
Residential <1/4 acre	12.10	2.41	600	0.57
Residential 1/4 - 1/2 acre	9.84	1.87	466	0.13
Residential > 1/2 acre	7.83	1.57	346	0.10
Commercial	9.01	1.69	606	0.90
Industrial	11.00	1.86	563	0.75
Urban Open	5.59	0.809	266	0.01
Transportation	11.00	2.72	866	0.75
Waste Disposal	4.47	0.895	266	0.01
Water	2.59	0.647	104	0.01

Source: Michael L. Stoltzfus, Nonpoint Source Assessment Prioritization Technique Using Geographic Information Systems, analysis of aerial photographs of the Assabet River Watershed

Table IV-32: Non-Point Source Pollutant Loading by Sub-watershed and Subbasin

Sub-basin Identifier	Area Description	Total Acres	Nitrogen Lbs/yr	Phosphorus Lbs/yr	Suspended Solids Lbs/yr	Impervious Acres	Percent Impervious
North Branch Millers River							
7009	Lake Monomonac	1,380	3.07	0.31	64.50	25	1.85
Upper Millers River							
7001	Wallace pond	1,420	2.65	0.13	27.22	15	
7002	Lake Watatic	1,389	3.07	0.28	59.47	25	
7003	Upper Naukeag Lake	1,192	2.93	0.33	63.88	18	
7004	Lower Naukeag Lake	1,770	3.57	0.43	92.07	43	
7005	Bear Meadow Brook	1,277	2.19	0.13	27.71	16	
7006	Ashburnham State Forest	695	1.33	0.09	22.22	2	
7007	Sunset Lake	1,513	3.45	0.42	87.30	36	
7008	Lane Village, Sunset and Lower Naukeag Lakes	3,726	2.91	0.19	44.80	62	
7010	Whitney Hill, Wildlife Management Area	4,129	2.98	0.22	51.15	83	
7013	Upper Naukeag Lake	1,485	53.37	6.38	0.41	15	
		18,597	**78.45**	**8.60**	**476.23**	**316**	1.70
Otter River							
7011	Perley Brook/ Cowee Pond	750	2.62	0.12	25.87	8	1.03
7012	Perley Brook Reservoire	1,014	3.28	0.32	79.61	37	3.63
7026	Templeton Brook and Templeton State Forest	2,897	3.04	0.23	61.51	86	2.96
7028	Bents Pond, Warren Cemetary	1,585	2.86	0.24	59.01	51	3.22
7029	Southeast Edge of Gardner	4,897	4.22	0.56	141.55	390	7.97
7030	Center of Gardner	1,283	3.73	0.45	111.22	85	6.59
7032	Junctions of Routes 2, 2A, and 68, Gardner	949	8.51	1.57	426.98	361	38.02
7034	Templeton Municipal Airport	665	4.69	0.71	207.44	100	14.99
7035	Kendall Pond, Otter River	518	6.09	1.12	325.12	137	26.48
7042	Wilder Brook	1,506	3.00	0.21	49.08	28	1.88
7043	Crystal Lake	629	4.36	0.75	189.10	48	7.67
7044	Parker Pond	5,164	4.46	0.62	160.75	466	9.03
7045	Bailey Brook	2,033	2.74	0.15	33.90	27	1.33
7047	Town Farm Road, Winchendon	3,268	3.38	0.33	79.94	88	2.70
7049	Trout Brook, Templeton	5,073	3.41	0.36	103.72	228	4.49
7051	Stoddard Pond	1,970	2.83	0.22	45.28	29	1.46
7052	Beaver Brook, Baldwinville	4,744	3.73	0.45	115.87	185	3.90
7054	Birch Hill Dam Area	466	2.65	0.15	33.69	7	1.60
		39,411	**69.59**	**8.56**	**2,249.61**	**2,360**	5.99
Tarbell Brook							
7014		4,278	4.16	0.55	148.31	294	
7017		371	2.82	0.15	40.39	4	
		4,649	**6.98**	**0.70**	**188.70**	**299**	6.42
Middle Millers River							
7015	Whitney Pond	4,278	4.16	0.55	148.31	294	
7016	Birch Hill Dam	1,812	2.76	0.20	43.55	31	
7025	Lake Dennison	2,213	3.27	0.34	76.70	59	
7056	South Royalston	2,312	2.64	0.15	32.21	26	
7059	Queen Lake, Phillipston	5,683	3.09	0.27	71.67	150	
7062	Reservoir, Phillipston	270	2.90	0.25	61.03	5	
7063	South Royalston	1,661	3.07	0.25	60.85	27	
7064	Harvard Forest	1,817	2.88	0.18	45.10	25	
7065	Thousand Acre Swamp	578	2.72	0.14	30.71	7	
7066	Wildlife Management Area	5,475	3.28	0.30	78.41	177	
7087		1,288	3.31	0.33	78.45	45	
7089	Reservoir # 2	562	2.98	0.27	55.17	10	
7102	Orange Airport	1,027	4.46	0.70	201.87	140	
7106	North Pond Brook	276	3.16	0.25	57.61	5	
7113	North Pond Brook	715	3.26	0.28	62.23	14	
7117	Athol/Orange CBD's	9,889	4.48	0.62	169.81	903	
		39,857	**52.42**	**5.07**	**1,273.67**	**1,917**	4.81

Sub-basin Identifier	Area Description	Total Acres	Nitrogen Lbs/yr	Phosphorus Lbs/yr	Suspended Solids Lbs/yr	Impervious Acres	Percent Impervious
Scott/Priest Brook							
7018		538	2.65	0.10	22.06	5	
7019		1,163	2.81	0.16	41.05	15	
7022		1,496	2.85	0.17	40.19	19	
7023		3,084	2.66	0.12	26.02	34	
		6,282	**10.97**	**0.55**	**129.32**	**73**	1.17
Lawrence Brook							
7073		1,696	2.67	0.13	28.26	18	
7074		2,828	2.84	0.17	46.77	34	
7075		3,808	2.78	0.16	39.62	47	
7078		886	2.78	0.13	33.38	10	
		9,218	**11.07**	**0.60**	**148.04**	**109**	1.18
Tully River							
7076		3,353	2.81	0.22	49.97	45	
7077		2,582	2.72	0.15	35.95	31	
7079		3,413	2.64	0.13	31.50	37	
7080		2,898	2.77	0.16	41.45	36	
7082		2,348	3.15	0.32	93.94	49	
7085		3,149	3.56	0.40	104.51	89	
7096		2,274	2.71	0.12	29.05	24	
7098		1,356	2.67	0.13	31.23	15	
		21,373	**23.03**	**1.62**	**417.59**	**327**	1.53
West Brook							
7088		1,702	2.79	0.18	52.53	22	
7090		2,133	2.69	0.17	39.43	24	
7092		2,021	3.30	0.33	95.71	69	
		5,855	**8.77**	**0.67**	**187.66**	**115**	1.96
Lake Rohunta							
7093	Riceville Pond, Petersham State Forest	4,607	2.79	0.17	38.11	60	
7094	Thrower Brook, South Athol Pond	757	3.15	0.26	56.44	14	
7097	McIver Brook, Spectacle Pond	1,616	2.83	0.19	40.83	20	
7099	Ellinwood Creek, White Pond	2,713	3.44	0.35	81.79	64	
7101	Lake Rohunta	3,277	3.14	0.33	78.97	71	
		12,969	**15.35**	**1.30**	**296.13**	**229**	1.77
Gales Brook							
7104		2,051	2.77	0.17	35.99	24	
7105		2,571	2.79	0.16	35.53	37	
7107		1,838	2.87	0.19	47.70	30	
		6,459	**8.43**	**0.52**	**119.21**	**90**	1.40
Moss Brook							
7108		1,442	2.94	0.21	44.60	22	
7109		3,300	2.77	0.15	37.20	40	
7111		3,013	2.68	0.12	27.62	33	
		7,755	**8.40**	**0.48**	**109.42**	**96**	1.23
Whetstone Brook							
7119		3,134	2.60	0.10	22.56	32	1.03
Lower Millers River							
7120	Wendell	2,437	2.87	0.18	44.17	34	
7122	Jacks Brook	1,296	2.88	0.20	46.51	19	
7124	Keyup Brook	3,228	2.79	0.14	32.90	47	
7127	Erving/Wendell	4,535	2.79	0.16	36.61	76	
7128	Mormon Hollow Brook	3,548	2.71	0.15	32.40	43	
7129	Lyons Brook	2,256	2.69	0.14	31.96	27	
7131	Poplar Mountain	4,764	3.34	0.33	84.11	211	
		22,064	**20.07**	**1.30**	**308.66**	**457**	**2.07**
Watershed Total		**199,002**	**319.20**	**30.40**	**5,991.30**	**6,445.45**	**3.24**

Several areas in the Otter River have considerable land area with impervious surfaces. *(See Table IV-33*) Three areas exceed 11% and would be considered impacted. Two of these exceed 25% and would be considered non-supporting. The extent of impervious surfaces implies that stormwater must be managed to control the velocity of runoff and ensure that roadways and parking lots are properly drained. As the amount of impervious surface increases, so too does the estimate of nutrient and suspended solids load. In this area nutrients would come from applications of fertilizers or failing sewerage systems and septic systems. These areas are significantly urbanized and are comprised of high-density residential, commercial and industrial land uses. Perhaps the Gardner area of the Otter River Subwatershed should be the focus of an investigative study into stormwater impacts and land use management practices.

Table IV-33: Otter River Watershed Nutrient Loading and Impervious Surface

Area Description	Acres	Nitrogen Load Lbs/Acre	Phosphorus Load Lbs/Acre	Suspended Solids Lbs/Acre	Acres Impervious Surface	Percent Impervious
Junctions of Routes 2, 2A, and 68, Gardner	949	8.5	1.6	427.0	361	38.0
Kendall Pond, Otter River	518	6.1	1.1	325.1	137	26.5
Templeton Municipal Airport	665	4.7	0.7	207.4	100	15.0
Parker Pond	5,164	4.5	0.6	160.7	466	9.0
Southeast Edge of Gardner	4,897	4.2	0.6	141.5	390	8.0
Crystal Lake	629	4.4	0.7	189.1	48	7.7
Center of Gardner	1,283	3.7	0.4	111.2	85	6.6
Trout Brook, Templeton	5,073	3.4	0.4	103.7	228	4.5
Beaver Brook, Baldwinville	4,744	3.7	0.5	115.9	185	3.9
Perley Brook Reservoir	1,014	3.3	0.3	79.6	37	3.6
Bents Pond, Warren Cemetery	1,585	2.9	0.2	59.0	51	3.2
Templeton Brook /Templeton State Forest	2,897	3.0	0.2	61.5	86	3.0
Town Farm Road, Winchendon	3,268	3.4	0.3	79.9	88	2.7
Wilder Brook	1,506	3.0	0.2	49.1	28	1.9
Birch Hill Dam Area	466	2.7	0.1	33.7	7	1.6
Stoddard Pond	1,970	2.8	0.2	45.3	29	1.5
Bailey Brook	2,033	2.7	0.1	33.9	27	1.3
Perley Brook/ Cowee Pond	750	2.6	0.1	25.9	8	1.0
Total	**39,411**	**69.6**	**8.6**	**2,249.6**	**2,360**	**6.0**

Models are not intended to replace field monitoring or site evaluation, but they can provide a means of setting priorities for targeted field monitoring and site evaluation in the watershed. This model is only an indicator of general conditions. It is not an appropriate tool for site-specific engineering decisions. It does not consider surface and groundwater flow rates, permeability of soils, or absorption rates. It also does not account for distance of travel from the source. In addition, the coefficients for nutrient loads, suspended solids, and impervious surfaces were developed for another watershed. The use of land is likely to vary considerably from that of the Assabet River Watershed, since that area is more suburban. This analysis should be developed for the Millers River Watershed using coefficients developed specifically for this watershed.

V. Stream Team Nonpoint Source Assessments

The Riverways Program of the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE) developed the Adopt-A-Stream Program that establishes Stream Teams that monitor the rivers in response to local concerns. The Stream Team process began with a preliminary meeting of the people concerned about the Millers River, such as users of the river, civic groups, landowners, town officials, business groups, etc. They discussed their concerns, recorded their observations of the river, and set up a committee to conduct a shoreline survey.

The shoreline survey is an important step in the water quality monitoring process. It serves as a means of outreach to the public affected by the river. The purposes of the shoreline survey are to engage volunteers in a study of the vital signs of the river, identify and report immediate problems to proper authorities, and prioritize short- and long-range mitigation work to be done. For the Millers River Team the survey was used as a planning tool for targeting resources at areas in need of further effort. Team efforts involve seven steps:

1) Gathering data
2) Designing a water quality monitoring program
3) Finding causes of high coliform counts
4) Tracking polluted run-off
5) Protecting land
6) Protecting or restoring habitat
7) Promoting citizen awareness

When the Montachusett Regional Planning Commission (MRPC) and the Franklin Regional Council of Governments (FRCOG) contracted with Department of Environmental Protection to conduct a Millers River Watershed Nonpoint Source Assessment, they took on the task of developing the public participation process in the planning effort. *(See Appendix E)* To recruit volunteers a series of meetings were planned and announced with pres releases. The first press release, dated June 15, 2000, announced the awarding of the contract to the two agencies and informed the public of the intent of the project.

The next press release, dated October 27, 2000, announced a Kick-Off Celebration, scheduled for November 2nd, 2000, from 6:30 to 9:00 P.M. at Harvard Forest, Fisher Museum, in Petersham, MA. The press release informed the public that they were looking for volunteers to perform a shoreline survey along sections of the Otter and Tully Rivers, two main tributaries of the Millers River. The announcement canvassed landowners, students, wildlife enthusiasts, sportsmen, professionals, elected officials, community volunteers, and others.

Letters went out on November 9th, 2000 to the Otter abutters and on November 13th, 2000 to the Tully River abutters, announcing the intent of the survey and the dates it would take place, inviting the landowners to participate, and assuring them that private property rights would be respected.

On November 13, 2000, a press release announcing the date of shoreline survey training went out. It described the work to be done and the method of approach, and requested more volunteers. The training was scheduled for Thursday, November 16th, from 6:30 to 8:00 pm at the Millers River Environmental Center at 100 Main Street in Athol. At the same time flyers were distributed to the area residents as an additional reminder.

On November 16, a group of forty volunteers met at the Millers River Environmental Center to learn about conducting a Shoreline Survey. Amy Singler, of the Massachusetts Adopt-A-Stream Program guided the group through the process using her slide presentation. The volunteer river stewards formed teams and selected different sections of the Tully and Otter Rivers, two major tributaries of the Millers River. Each team was provided with maps and guide sheets and was enthusiastic to get into the field. Over the course of two weeks, these teams assessed their sections of the two rivers by walking stretches of shoreline or traveling by boat down these rivers, observing and recording important in-stream and land use characteristics. Table V-1 lists the volunteers who participated in the shoreline survey effort.

Table V-1: Stream Team Members

Otter River		Tully River	
Deforest Bearse	Ernie King	Vyto Andreliunas	Joyce Rychlick
Laurie Connors	Jessi Manty	Earl Baldwin	Bruce Shearer
Glenn Eaton	Sharon Manty	Ron Cloutier	Dave Small
Victoria Eaton	Laila Michaud	Sue Cloutier	Don Stone
Steve Farrell	Dan Nolan	Pat Fellows	Rocky Stone
John Henshaw	Rick Paquette	Rachel Horowitz	Ann Townsend
Deb Hubbard	Tracey Paquette	Warren Kimball	Keith Williams
Rob Hubbard	Rich Turcotte	James Mallet	Jim White
John Hume	Ralene Williams	Greg McGuane	Michael Wright
		Mason Phelps	Greg Wright
		Alice Rojko	

On November 22, 2000, a press release announcing a meeting to share the survey results went out. The meeting was scheduled for Thursday, December 7th from 6:30 to 8:00pm, at the Millers River Environmental Center, 100 Main Street in Athol.

On December 7th, a group of thirty volunteers gathered at the Millers River Environmental Center in Athol to share the results of their shoreline surveys. Results of this meeting were announced in another press release that went out on December 8, 2000. The breathtaking beauty of the rivers moved many of volunteer surveyors. Wildlife, including a variety of birds, beaver, muskrat, fox, deer, and moose, abound. Invasive plants, such as purple loosestrife and phragmites do not yet plague riverbanks and adjacent wetlands as they do throughout Massachusetts. Historic features dot the landscape, offering exciting opportunities for interpretive trails.

Volunteers were concerned with the lack of accessibility to the river, which prevents many from enjoying the natural beauty and limits recreational opportunities. Residential dumping and the remnants of industrial activity mar a few places. One observer noted a "pool of orange goo" that most likely reaches the river at times of heavy rainfall. Erosion is a problem in areas and scattered, dilapidated structures pose risks to public health and safety.

The December 8th press release announced the scheduling of another meeting of the two teams to formulate an action plan, and put forth another call to action for interested volunteers. The meeting would be held on Thursday, January 18th from 6:30 to 8:00pm at the Millers River Environmental Center, 100 Main Street in Athol. The purpose of the meeting was to address the concerns identified in the survey results and create a watershed action plan that would incorporate Millers River Watershed Basin Team and Millers River Watershed Council goals. This release was followed up with another that went out on January 11, 2000 reiterating the call to action inviting people to participate in the Action Plan Meeting.

Shoreline Survey Results

To conduct the shoreline survey, the Stream Teams divided the river into walk-able or boat-able segments. Impenetrable riverbanks or concerns of property owners dictated whether the survey teams walked or canoed. Both rivers were divided into eight segments each. Teams of two or three people were assigned to each segment of the river. The teams surveyed the river, noting their observations, taking photographs, and identifying key areas on maps. The teams then evaluated what they found and developed plans and priorities for mitigation. Critical areas were reported to the state.

Using the field data sheets, the Stream Teams identified several areas within each watershed that were experiencing problems as a result of land use impacts to natural resources. The following narrative summarizes what the observers found. The stream teams identified a number of problems and assets on each segment, and made recommendations for courses of action as summarized in Tables V-2 and V-3. Problem locations are marked on the Potential Nonpoint Sources Map from the previous chapter. The stream team study areas are shown on the Otter River and Tully River Subwatershed maps that precede the tables.

1. Otter River Shoreline Survey

Segment 1 New Boston Cemetery (Winchendon) to Michaels Lane (Templeton) This segment corresponds to Segment MA 35-08 of the water quality assessment. The segment abuts the Otter River State Forest on west bank and Waite Field on east bank. Surveyors kayaked the river to conduct the survey. They put into the water at the confluence of the Otter and Millers Rivers. At this point the water was dark and clear. There was an odor to the river much like the odor from the Sewage Treatment plant on a humid summer evening. The current between the bridge abutments was very strong. Several cans and bottles littered the shore near the old road bridge. Ducks were spotted on the river beyond the railroad trestle and near the marsh grass on the east shore upstream. Submerged paddles brought up a light gray sandy silt. The west bank vegetation was comprised of deciduous and pine trees. The east bank was comprised of marsh grass. Surveyors observed a tall propane tank bobbing in the center of the river twoo hundred feet north of the washed out footbridge.

Segment 2 Michaels Lane to Cottage Street (Templeton) - This segment also corresponds to Segment MA 35-08 of the draft water quality assessment**.** The assessment reported that the segment contains PCB's. This segment seems to be the most influenced by an urban environment. The survey began at the former Baldwinville Products Paper Mill, now owned by American Tissue Mills. This is clearly the most negatively impacted area in the segment. The river flows next past the Templeton Wastewater Treatment Plant and through Baldwin center where several pipes drain to the river. Following this "urban" area, the river flows past the ruins of several factories destroyed in the flood resulting from the Hurricane of 1938. The river then peacefully winds its way past the back bays of Baldwinville in an area under the flood control of the US Army Corps of Engineers.

Segment 3 Cottage Street to Liberty Street (Templeton) This segment also corresponds to Segment MA 35-08 of the water quality assessment**.** The survey segment started at the railroad bridge crossing in Otter River Village and ended at the abandoned mill in Baldwinville near the Town Office Building. This section of the Otter River is almost entirely undeveloped with the exception of the Templeton Wastewater Treatment Plant and the abandoned mill building. The north shoreline is forested with white pine and mixed hardwoods. A significant wetland dominated by emergent herbaceous plants is located along the river's edge. This wetland also contains a shrub component dominated by speckled alder and red maple. A number of small campsites are scattered along the shoreline. Evidence of beaver activity was seen along the shoreline, although only one active lodge was observed. Two intermittent tributary streams and one culvert were found along the north shore. The stream nearest the old mill showed signs of poor water quality (cloudy water, brown residue, and discharge through the 12 inch diameter culvert). Large wetlands border the Otter River near the wastewater treatment plant. Near the railroad bridge the left shore had exposed sand possibly from use of All-Terrain Vehicles.

Segment 4 Liberty Street (Templeton) to Turner/Bridge Street (Templeton) - This segment corresponds to Segment MA 35-07 of the water quality assessment. It is a short segment that begins at Liberty Street in Otter River Village near the Seaman Paper Company and ends at the Turner/Bridge Street Bridge just after St. Joseph's Cemetery. Observers noted that most of the area was characterized by undeveloped stream banks with no public access. Exceptions included: the Seamans Paper Mill and Treatment Plant and its parking lot; new bridge construction at Turner/Bridge Street Bridge; houses on the riverbank at Turner/ Bridge Street, Pine Drive, and Hamlet Mill Bridge; and new street drains at Hamlet Mill Bridge. There was evidence of a lot of beaver activity and pheasants due to stocking by the Sportsmen's Club. Potential for creation of public access exists at Mill Pond, at Hamlet Mill near the Old Mill, at Pine Drive, and off Bridge Street in Gardner.

Segment 5 Turner/Bridge Street to Riverside Road (Templeton) – This segment also corresponds to Segment MA 35-07 of the water quality assessment. Since this segment was very long, the team split it in two. It abuts Wildwood and Notre Dame Cemeteries and flows by the dump. The river flows rather swiftly through this segment, although riffles are not evident. The water ran clear. Grass and trees grow on steep banks. Dense pine forest is found along the right bank, above the grass/shrub buffer. Standing dead trees and fallen limbs offered potential for wildlife habitat. Because hunters could be heard, it was not surprising that we saw very little wildlife. Most of the segment appeared to have very little human intrusion. Very little litter was found and there were no formal trails. Only near Riverside road were there any residential or commercial uses. At Riverside Road erosion was a problem. Two large gravel operations along the segment and bridge construction at Turner/Bridge Street Bridge may be contributing sediments to the river.

Segment 6 Riverside Road (Templeton) to Coleman Street (Gardner) - This segment also corresponds to Segment MA 35-07 of the water quality assessment. The relatively short segment begins at Coleman Street, just north of the Gardner Wastewater Treatment Plant. It abuts Parker Pond on east bank and flows westward, passing a railroad bed and a junkyard. At the starting point is an exposed sewer line that crosses the river. Through this area the river flows slowly through wetlands to Parker Street (Route 101). A restaurant on Route 101 has a parking lot that exhibits evidence of erosion from runoff and snowmelt. North of Route 101, three drain pipes empty storm water from Route 101 directly into the river. One is in the northwest bridge abutment, and the others are on each bank of the river.

Two hundred feet downstream, a tangle of branches obstructed the river. At this point, an auto repair shop property abuts the river. The property had an oil storage facility, an auto body shop and several cars and trucks parked behind the shop. Tangled vegetation made it difficult to walk the riverbank. Across the river is a dump of old tires and demolition material consisting of wood and porcelain. Further downstream more fallen branches form an obstruction with vegetation growing between the branches. Nearby a tributary from Parkers Pond joins the river.

Downstream of this point is an extensive wetland that contains a breached beaver dam. The river varies in depth from two to three feet. Foam was seen floating downstream and there was evidence of small amounts of aglae. Two small tributaries of undetermined origin flow into the river. Eventually, the wetland narrows as the river approaches a bridge. On the right bank is an encampment used most likely by teenagers or some of the area's homeless. An elevated railroad runs behind the encampment and wooden or metal man-made items were seen in the river. Further on is the Riverside Junkyard, a large auto-recycling center, on the right bank of the river. Many junk cars are located on pervious gravel. If fluids are not properly disposed of or leakages controlled for, they could seep into the groundwater.

Beyond the wetlands is an area of thick brush and trees merging into woodlands. Here the ground was littered with broken clay and plastic flowerpots, other debris, and an old stove. A mix of houses and small commercial businesses are located two hundred feet upland from this point. The segment ends at the Riverside Road Bridge, which has four roughly poured concrete drain troughs that direct water into the river.

Segment 7 Coleman Street to Route 2A (Gardner) – This segment corresponds to Segment MA 35-06 from the water quality assessment. It is adjacent to the West Gardner Industrial Park. The river flows slowly, but fast enough to create ripples and visible current6 channels where obstructions or constrictions occur. Impacts from development are mostly located at the beginning and end of the segment, where roads cross the river. The majority of the segment is undisturbed, especially the east bank, which consists of a very wide grassy floodplain. Chest high grasses (phalaris, calamagrostis) with occasional shrubby high spots cover a large area. Closer to the stream, grasses gave way to sedges. Vegetation within the stream had died back for the winter. The west bank had areas with steeper banks and wooded areas. Both banks had areas of wooded swamp with wildlife habitat. The Gardner Wastewater Treatment plant is located on the west bank, and is noticeable. There was a lot of evidence of wildlife.

Segment 8 Route 2A to Mill Street (Gardner) - This segment also corresponds to Segment MA 35-06 from the water quality assessment. Beginning at the intersection of Sawyer Street and Mill Street, in Gardner, the river flows westward to a bridge on Route 2A at the Duguay's Restaurant. The starting point of the survey is a small 2-lane tarred bridge crossing the Otter River. The river is approximately 10-15 feet wide, 1-2 feet deep, running at a consistent medium speed with some ripples. The water runs rather clear, showing a stony bottom. A white foamy substance was seen at the edges and rocks. There was no noticeable odor or signs of trash. The embankments were covered in leaves and small growth, with riprap on the Northeast bank at the bridge area. In this riprap is an 18-inch cement pipe from a street catch basin, less than 10 feet from the river, with water trickling out. Along the North side is a small walking trail that follows the river for quite a ways. The remnants of an old Pail factory dam exist, demolished in the 1938 Hurricane.

Approximately 300 yards North from the Sawyer Street/Mill Street Bridge the marshland begins, limiting access to the river. The water still appears quite clear, running at a medium speed in the center and slow moving or pooled at the edges. Stones and rocks are scattered on the bottom. Homes with small yards and no barriers

are located at the edges of the marshes. The river passes under a dirt road via a 3-foot rusty metal culvert. Whitney Street at this location has minimal buffer, with loose dirt, sand and gravel able to flow into the river and marsh.

The other end of the segment is located on Route 2A at the Gardner/Templeton town line. Approximately 100 yards South of the Route 2A bridge is a small, old railroad bridge. The railroad tracks are gone, and the path-way is overgrown. This bridge is deteriorating, falling directly into the river below. This deterioration is most likely caused by the salting/sanding of the road above. The Gardner Waste Water Treatment Plant and the Gardner dog pound are located farther west. The marsh water seems to remain relatively clear. The bottom contains rocks and stones, where shallow enough to see the bottom, and the water begins to look darker, as a cup of coffee would, clear but brownish tint. The bed looks murky and silty, as well as light brown. The water runs deeper, wider and slower in this area. Cans and plastic items were seen on the waterbed and banks. Some trash could be atttributed to Duguay's Restaurant, located 20 feet above the river on a steep incline of fill on the East bank of the river at this location. Runoff and snowmelt are free to travel into the river. An 18-inch metal pipe is embedded in the banking, surrounded by overgrowth.

Across the street to the North, a noticeable amount of garbage was seen, possibly from the vehicles above, or the restaurant across the street. A large open area with many vehicles is located on the west side of the river. On the East side of river a roadway catch basin cement pipe drains into the river. A great deal of underwater growth at the mouth of this pipe is likely the result of a fallen tree in the river.

At the entrance to the Gardner Municipal Airport, a shallow, rocky, narrow, declining path provides access to another marshy area. The water is less than a foot deep, clean, clear, with no odor, although some white foam is found at bottom of the "falls". Beer cans and bottles were seen in this area. The remnants of what appears to be a beaver dam are also at this narrowing. Surrounding vegetation shows signs of beaver activity. An island in the marsh shows signs of human presence such as a milk crate, vehicle tracks, and footprints. Venturing into the wooded area, 20 feet from the water's edge, is a bituminous dumping pile. More aggressive patrolling of the area may discourage dumping/polluting. on the very outskirts of the airport clearing are signs of runoff that eventually drains into the watershed, after filtering and dispersal from the landscape.

Map: Otter River Subwatershed

Table V-2: Otter River Stream Team Shoreline Survey Results

Segment	Problems	Assets	Priorities
Segment 1: - Confluence with Millers River to Micheals Lane			
Team Jessi and Sharon Manty	1) Litter around bridge abutments. 2) Large cylinder bobbing in stream center.	1) Excellent wildlife habitat- vegetation hanging over banks, snags, and fallen tree limbs and trunks. 2) Evidence of wildlife including ducks and beaver. 3) Wide riparian buffer. 4) Otter River State Forest sandwiches river.	1) Clean up litter around bridge abutments. 2) Remove large cylinder from stream center.
Segment 2: Micheals Lane to Cottage Street			
Team John Henshaw Ralene Williams Steve Farrell	1) Contamination at idle American Tissue Mills ("pool of orange goo," rotting paper bales, rusty 55-gallon drums. 2) Residential dumping, especially behind old service station. 3) Runoff from pipes leading to excessive algal and moss growth. 4) Old dam impedes natural flow. 5) Dirt road near sewer pumping station lacks siltation fence.	1) Significant recreation potential- excellent river access along many trails and Otter River State Forest. 2) Rich wildlife habitat. 3) Natural setting with historic remnants. 4) Old dam near Maple Street Extension shows potential for a recreation bridge across the river.	1) Investigate potential hotspots, including paper mill area and pipe effluents. 2) Initiate Clean-up Program to remove debris and house trash. 3) Develop plan and apply for grant for historic/nature trail along river, including rebuilding footbridge across river. 4) Determine options for removing all or part of old dam to open the river up for recreational canoeing and kayaking. 5) Test pipe effluent and mitigate if it's a problem. 6) Install a siltation fence at dirt road.
Segment 3: Cottage Street to Liberty Street			
Team Rick and Tracy Paquette	1) Intermittent stream nearest old mill shows signs of poor water quality (cloudy water with rust/orange coating on rocks and substrate). 2) Possible PCB contamination from Templeton Wastewater Plant. 3) Exposed sand found on shoreline by the railroad bridge. 4) Debris and dilapidated structures mar abandoned American Tissue site. 5) Formal public access lacking.	1) Vegetated riparian zone is in excellent condition and wide (greater than 1000 ft.) 2) Almost entire shoreline is currently undeveloped. 3) Excellent wildlife habitat. 4) Informal trails present. 5) Recreation potential for canoeing and fishing up to old American Tissue Mill.	1) Encourage DEP and EPA to enforce cleanup of PCB contamination. 2) Remove dilapidated structures. 3) Protect undeveloped land. 4) Consider providing canoeing access.
Segment 4: Liberty Street to Turner/Bridge Street			
Team Rob and Deb Hubbard	1) Lack of access. 2) Lack of protected land. 3) A few houses and paper mill within 100' buffer. 4) Street drain at Hamlet Mill Bridge shows moderate flow from paper mill treatment plant (Seamen's Paper).	1) Undeveloped land provides good habitat. 2) Canoeing possible at Mill Pond. 3) Adjacent to Sportsmen's Club land (virtually protected).	1) Protect undeveloped land. 2) Consider providing canoeing access.

Table V-2 Cont.

Segment	Problems	Assets	Priorities
Segment 5A: Turner/Bridge Street to Notre Dame Cemetery			
Team Laila Michaud John Hume Laurie Connors	1) Oily sheen found adjacent to landfill. 2) Possible erosion/ sedimentation from adjacent gravel operation. 3) Noise pollution from gravel pit. 4) Formal access nonexistent.	1) Good wildlife habitat (wetlands prevalent) that provides linkages to other habitat types. 2) Beaver, deer, pheasant, heron, kingfisher, and grouse seen.	1) Monitor contamination from the Gardner landfill. 2) Investigate Bridge Street construction to determine if implementing Best Management Practices. 3) Reduce noise at gravel operation. 4) Improve mitigation measures at gravel operation.
Segment 5B: Notre Dame Cemetery to Riverside Road			
Team Laila Michaud John Hume Laurie Connors	1) Erosion along Riverside Road. 2) Two abandoned gravel operations may be contributing sediments to the river. 3) Riverside Auto Salvage may be a problem due to presence of rusting cars on very pervious gravel. 4) Residential dumping adjacent to river.	1) Tremendous recreational potential (boating, walking, fishing) 2) Aesthetically pleasing- beautiful stands of coniferous trees. 3) Excellent wildlife habitat.	1) Improve mitigation measures at gravel operation. 2) Secure abandoned gravel operation. 3) Investigate Riverside Auto Salvage to see if implementing Best Management Practices.
Segment 6: Riverside Road to Coleman Street			
Team Ernie King	1) Stream flow blocked by trash. 2) Runoff from parking lot. 3) Residential and commercial dumping areas. 4) Small amounts of algae present. 5) Homeless/teenager encampment.	1) Excellent wildlife habitat. 2) Extensive wetlands along east bank.	1) Clean up trash in stream and encampment. 2) Design improvements to stormwater management at parking lot 3) Monitor dumping areas for leachate.
Segment 7: Coleman Street to Route 2A			
Team Rich Turcotte	1) Odor from sewage treatment plant permeates area. 2) Oily sheen or smell from pipe that yields reddish deposits. 3) Old trucks stored within riverfront area.	1) Extensive wetlands, including wooded swamp. 2) On Natural Heritage Map, this section is designated "estimated habitat." 3) Potential canoe access on bridges at both ends, limited canoeing range however. Fishing and canoe access possible.	1) Construct a boardwalk to provide access to wetland area along segment 7. 2) Test and mitigate pipe effluent if a problem is found. 3) Determine whether old trucks are causing any pollution problem.
Segment 8: Route 2A to Mill Street			
Team Glenn and Tori Eaton	1) Clean up of trash needed near airport. 2) Dirt road passes over river, enabling sediments to be deposited easily in river. 3) Bridge is deteriorating, falling directly into the river. 4) Runoff from parking lot. 5) Vegetation growing at pipe outflow point. 6) No vegetated buffer around Snake Pond where significant residential development is situated.	1) A road or path from the entrance of the airport provides some access. 2) Potential boat launch site near airport.	1) Determine feasibility of building a boat launch near the Gardner Municipal Airport. 2) Discourage dumping near the Gardner Municipal Airport by aggressive patrolling. 3) Plant vegetated buffers adjacent to harmful land uses to filter out pollutants. 4) Rebuild bridge, mitigate road sediments washing into river

2. Tully River Shoreline Survey

East Branch of the Tully River

Section 1 Royalston Road or Outfall of Tully Dam and the Gauging Station to Fryeville Road - This section begins just downstream of the Tully Lake Dam and was observed by the team as very pristine with ideal recreation opportunities that include fishing and hiking. The team did note several solid waste dumping problems near the third pond.

Section 2A Fryeville Road to Gravel Pit and Dump - Approximately the first 0.25 miles ascends gradually in a southerly direction. The stream varies in width from 35 to 40 feet down into a marsh with dense woody vegetation. There is significant beaver activity creating some flooding at the toe of slope near the closed Town of Athol landfill. Iron appeared to be leaching from the landfill into the bordering wetlands.

Section 2B Gravel Pit and Athol Landfill to Pinedale Avenue Bridge. - The river is in excellent condition as a free flowing natural area providing good habitat for fish and other aquatic life, birds and animals. Excellent wildlife habitat that included cover and margins for the full length of this section. Dry stone construction of an old bridge abutment also offering good habitat. The Team encountered old gravel pit with some abandoned white metal appliances.

Section 3 Pinedale Road to confluence of W. Br. Tully River - The south bank at the start of this walk is in deep shade of hemlock and mixed stand of hardwood trees. The team noted the area has good potential for vernal pools. The trail is old and not easy to walk for this first 500 feet. There was evidence of mixed household rubbish, white metal goods, glass and plastic debris. The team also observed an abandoned car, several car tires and an empty 55-gallon barrel.

West Branch of the Tully River

Section 1 North of Fish Brook to Collar Brook - The Team considered this segment pristine. The water moves rapidly through alternating pools and riffles creating good habitat and well-oxygenated water. The streambed has a combination of gravel, cobbles, sand and boulders creating good aquatic habitat. There are numerous small runoff channels entering the river on the west side. There are several small islands in the river. The stream banks are eroded in several areas but do not appear to be caused by anthropogenic disturbances within this reach of river. Beaver activity may lead to some flooding upstream.

Section 2 Tully Road to Royalston Road - This section of river has two distinctly different personalities. The main stem of the Tully River is very pristine. Generally, the river meanders through undeveloped landscape that is dominated by woody vegetation predominately hemlock and pine. The wetland areas did show significant signs of beaver activity.

The second part of this stream section is the outfall of Tully Pond that has a large granite revetment along the bank and appears to have been channelized to accommodate a spillway for Tully Pond.

Section 3 Confluence of the East and West Br. to Western Ave - The East Branch flows strongly into the West Branch, which has less current. There is a good deal of riffles and pools. The streambed is comprised of gravel and cobble. The watercolor was dark brown possibly due to tannic acid. Several trees were blown down across river channel providing good fish habitat but poor canoe or kayak access.

Section 4 Western Ave. to Millers River - The river meanders through a broad shrubby wetland/marsh from Lenox Street south to the north side of Carr Meadow. There is considerable evidence of beaver activity. The stream widens considerably at the south end of the marsh. This area appeared to be unspoiled by anthropogenic disturbances.

Map: Tully River Subwatershed

Table V-3: Tully River Stream Team Shoreline Survey Results

Stream Section	Problems	Assets	Priorities
East Branch of the Tully River			
Section 1 - Royalston Road or Outfall of Tully Dam and the Gauging Station to Fryeville Road			
Team Rachael Horowitz Bruce Shearer	1) Trash at South end of Dam at Pond 3 (Haeshey Pond) 2) Trash at Feeder Brook and ponds above gauging station	1) Good woodland habitat, large buffer to Rt. 32 with few houses 2) Good fishing habitat, riffle pools abundant 3) Close to Tully loop trail with yellow blazes and proximity to Tully Lake	1) Dam Recreation area- could have good public access and lots of recreation potential 2) Dam at third pond needs cleanup of asphalt shingles, trash and metal drums
Section 2A - Fryeville Road to Gravel Pit and Dump			
Team Keith Williams Rocky Stone	1) Leach Tank adjacent to Brook 2) Iron leaching near pipe 3) Flooding due to beaver 4) Sedimentation barrier not well maintained and restricts movement of small animals	1) Good Riparian Buffer 2) Wetlands, shallow Marsh Beaver habitat	1) Research leachate at toe of slope adjacent to the former Town Athol dump. 2) Consider removing siltation barrier
Section 2B - Gravel Pit and Dump to Pinedale Rd			
. **Team** James Mallet Don Stone	1) Large trash dump at gravel pit. Some appliances in dump area near stream. 2) Litter and debris at Pinedale Bridge Ave	1) Excellent Wildlife cover. Clear flowing water and good fish habitat. Section could provide good paddle sports but limited access. 2) Landowners along river long time residents, value and care for river. 3) Interesting old road bridge abutment. Dry set stone in excellent condition 4) Old dam and raceway site	1) Cleanup solid waste at Pinedale Ave Bridge. Good Boy Scout Project 2) Organize clean up day, remove old appliances 3) Improve recreational access for fishing and paddle sports.
Section 3 - Pinedale Road to West Branch Tully River			
Team Ron & Sue Cloutier Joyce Rychlick Pat Fellows	1) Solid Waste/Overbank dumping to include: barrels, tires and possible abandoned car 2) Raceway with bike and metal debris, various solid waste 3) Barberry (potential Invasive plant species) 4) Sportsman club - asphalt & debris pile 5) Bank soil erosion, northeast side of Pinedale Road	1) Eastern Hemlock riparian buffer 2) Wildlife presence including beaver, deer, mallards and domestic geese	1) Possibly acquire conservation easements for walking trails 2) Organize clean-up day through DPW and neighbors

Table V-3: Tully River Stream Team Shoreline Survey Results (Cont.)

Stream Section	Problems	Assets	Priorities
West Branch of the Tully River			
Section 1 - North of Fish Brook to Collar Brook			
Team Alice Rojko Warren Kimball	1) Small runoff stream with orange deposits appeared to be iron leaching naturally. 2) Naturally eroded banks depositing material into river 3) Sediment has been deposited in riparian area due to high water flow 4) Some solid waste debris near dirt road	1) Abundant riffle and pools indicating well oxygenated water 2) Good riparian buffer 3) Water is very dark (Possible Tannic Acid) 4) Pristine area	1) Consider approaching DEM about preserving land as open space 2) Organize stream clean up day for trash near dirt road
Section 2 - Tully Road to Royalston Road			
Team Michael Wright Greg Wright	1) Roadside debris near Tully Road 2) Potential flooding of roadway due to beaver presence	1) Excellent habitat for wildlife 2) Great Hemlock Riparian Buffer 3) Presence of beaver	1) Clean up trash along Tully Road
Section 3 - Confluence of the East and West Br. to Western Ave area			
Team Earle Baldwin Greg McGuane	1) Lead shot peppering substrate Sportsman pond, which drains into Tully R. 2) Restricted river access for recreation opportunities 3) Stream entering Right bank. Not indicated on Topo map carries road drainage from North Orange Road	1) Footpaths present along both banks of river 2) Remnants of gun club at confluence 3) Western Ave area there is a number of wood roads (gated) to the area	1) Lead shot and former shooting range should be assed for possible leaching and other environmental concerns 2) Town storing waste materials should be removed and provide recreational access.
Section 4 - Western Ave. to Millers River			
Team Ann Townsend Mason Phelps	1) Possible problem at pipe on Lenox street 2) Question effect of well field on water table 3) Trash along banks on Lenox Street	1) Good wildlife habitat 2) Good outdoor recreational areas canoeing, swimming and nature trails	1) Review further using canoe or small craft (non-motorized)

3. Middle Millers River Field Check for Winchendon, Athol, and Orange

In addition the shoreline survey effort, staff of the two regional planning commissions conducted field checks of urbanized areas in Winchendon, Athol and Orange. The lists below document their observations.

Table V-4: Middle Millers River Field Check for Winchendon, Athol, and Orange

Location	Observation	Recommended Action
Winchendon		
Whitney Pond		
1. George Whitney Bridge – On Ash Street crossing Whitney Pond	▪ Erosion due to stormwater runoff from the road is causing siltation in the pond at the North end of the bridge (mile marker 61.186, Route 12). ▪ A mix of Residential and Industrial uses edges the pond. ▪ Heading Southeast across the bridge, at the low point of the causeway, stormwater is eroding the embankment on the West side of the road into the pond. ▪ On the East side a storm drain appears to dump into pond. ▪ By the Texaco Station, someone used 6-foot x 6-foot posts and rubber tires to shore up erosion of the embankment at the low point of the property.	▪ Improve storm-water manage-ment ▪ Monitor sewer/septic sys-tems for failures
2. George Whitney Bridge 1973 – On High Street crossing Whitney Pond	▪ Erosion control measures have been imple-mented at the AT&T building, beside the dam. ▪ Storm drains at the South end of the bridge direct water into the pond. ▪ Siltation from an active sewage pipe, hidden under heavy brush, is polluting the pond on the Eastern side of the bridge, below the grade of the road.	▪ Improve storm-water manage-ment ▪ Redirect sewage effluent to sewer system
3. Abandoned Rail Bed East and West of George Whit-ney Bridge 1973, runs paral-lel to Water Street. (An old spur line?)	▪ Old railroad cinders and loose material on the old rail bed may pollute stormwater, which runs into Whitney Pond by a small stream that crosses under Water Street be-tween the two George Whitney bridges. ▪ West of George Whitney Bridge 1973, an erosion point due to ATV traffic allows cin-ders and oily material from the rail bed to leach into the impoundment at the dam. A 'no trespassing' sign was recently posted at the point of erosion. ▪ How does the furniture factory use the water from the impoundment in the manufacturing process? Is it being heated? ▪ A stream across from factory running through culvert dumps into the river.	▪ Determine own-ership and status of the rail bed right of way ▪ Excavate cinders ▪ Convert the rail right of way to a bike trail.

Location	Observation	Recommended Action
4. Near Junction of Route 12 and Route 202 (Glen Allen Road)	▪ The abandoned rail bed on the shore of Whitney Pond appears to be used by motorized vehicles. ▪ A large dirt parking lot seems to be a lay-over spot for large trucks ▪ There is evidence of some illegal dumping along the tracks	▪ Support the Gardner to Winchendon Rail Trail Project ▪ Determine ownership and purpose of the parcels at Glen Allen Road ▪ Consider converting use to trail and pond access parking lot and picnic area ▪ Clean up illegal dumping
5. George Whitney Bridge 1939 On Route 202 (Glen Allen Road)	▪ Significant erosion from storm drains on both sides of the bridge at its north end. Discharge areas were blown out and backfilled with sand and rock below the bridge.	▪ Improve stormwater management system
6. The Winchendon Golf Course (Spring Street)	▪ Potential runoff from the golf course may pollute a small drainage pond connected to Whitney pond by a culvert under Spring Street (Route 12). ▪ A Pump Station Restoration project sponsored by the USDA is adjacent to the golf course drainage pond. Measures are in place to try to prevent erosion.	▪ Monitor water quality of the drainage pond and Whitney pond at this location.
7. Good Speed Machine Co, off Summer Street.	▪ An abandoned railroad bridge adjacent to a newer bridge ▪ An old dam that served an old abandoned property, ▪ One building is in use on the site. The tenant is manufacturing concrete burial vaults. He has a slurry hole and slurry runoff runs down to a storm drain on Summer Street, near the athletic field ▪	▪ Investigate land uses to determine if there are water quality impacts
<u>North Branch Millers River</u>		
8. Mylec Ray Plastic Factory at Route 202 (Glen Allen Road), Maple Street and Lebreton Circle	▪ The factory dam at Whites Mill Pond diverts water from the impoundment and through a small channel under the factory through a culvert under Lebreton Circle to a retention pond at the confluence with North Branch. Does the factory change the temperature of the water? Does it have a discharge permit?	▪ Monitor water quality at the confluence of the North Branch and the retention pond ▪ Investigate discharge permit

Location	Observation	Recommended Action
9. Lake Monomonac (various roads off Route 202)	▪ The man-made lake is used for recreational purposes including boating and swimming. Residential properties edge the lake with potential for failed septic systems. The area is in process of building out, yet room for more housing still exists.	▪ Investigate septic/sewer systems for possible failures ▪ Monitor water quality where the lake drains to the Millers River
10. Route 202, Bridge at mile marker 78.136	▪ The retaining wall foundation of a commercial building at Elmwood Road is built on the bank of the North Branch, near the confluence of Whites Mill Pond and North Branch south of Lake Monomonac.	
<u>Millers River West of Whitney Pond</u>		
11. Baldwinville State Road below Tannery Pond	▪ Stormwater runoff at a bridge downhill from Tannery Pond (at the end of the state highway) has erosion potential due to the slope of the terrain and the curve of the road. ▪ An earth and rock dyke shores up the embankment of the river bend at the bridge (river bank erosion control). ▪ The abandoned rail bed passes nearby (oily cinders, leachate).	▪ Improve stormwater management ▪ Monitor bridge for erosion control
12. George Whitney Bridge 1964 in Waterville at Baldwinville State Road and Brown Road.	▪ Factories filled with furniture makers straddle the river here. Any discharge permits? Chemical spillage? Increases in water temperature? Dumping?	▪ Monitor water quality ▪ Investigate permits ▪ Survey river for dumping
13. Birch Hill Dam area/Lake Dennison	▪ The flood control system is prone to intermittent flooding that churns up sedimentary muck and detritus, which can result in rising levels of turbidity and siltation during and following the flooding. ▪ Swimmers at Lake Dennison may be a source of pollution.	▪
14. South Royalston Sewage Treatment tank-Blossom Street, Royalston	▪ Where does the effluent go? The embankment of Millers River is steeper here. The tank sits at the end of Blossom Street, but it isn't clear what happens to the effluent after it has been treated.	▪ Investigate discharge permit ▪ Monitor water quality downstream of the treatment tank

Location	Observation	Recommended Action
Millers River in Athol		
15. Chestnut Hill Avenue at Bridge Street on Route 32-134	▪ At the North end of the bridge on the west side, the stormwater discharges directly to the river through two 16" diameter pipes. Black plastic and stakes placed along the banking as erosion control measures are failing. Nearby intersection has safety and grade issues.	▪ Improve stormwater management ▪ (Long-term/future) Re-grade bridge (rebuild) and intersection level with Crescent Street
16. Banks of the Millers River	▪ Steep slopes exist on both banks of the river, East of the bridge and dams. Residential properties located at the top edges of the slopes have potential for erosion at the back of the lots.	
17. Springfield Terminal Railroad Bed – below Green Street	▪ For the whole length of the rail, old creosote-soaked railroad ties lie alongside the tracks just above the river. ▪ Numerous empty drums of grease were present. ▪ For the entire length of the rail line it seems the track is either eroding or corroding. There are many signs of wear. Are there plans to replace the rails? ▪ Streams run through culverts beneath the tracks. Creosote soaked railroad ties were dumped into the mouth of one stream.	
18. Greenwood Street	▪ An old dump was left on a steep slope above a stream in the woods off Green Street. ▪ Land below the dump is wet.	▪ Investigate dump for potential leachate impact to water flowage on the hillside
19. The Starett Buildings to Pioneer Plaza – Exchange Street and Marble Street	▪ Cannot access this stretch of the river due to the buildings. Could not evaluate the segment. ▪ Raised retaining walls above the parking lot protect the steep river bank from flood damage. The stretch of river between Starett and the Exchange Street Bridge to is rimmed by retaining walls, though it is not apparent because trees line the embankments. ▪ The private land uses and concrete walls eradicated public access to the river throughout this section. ▪ The plaza consists of a laundromat, a dry cleaning establishment, and a carwash. It has no obvious storm drainage facilities. Do they have permits? ▪ Encroachment of land uses with impervious surfaces on the river floodplain increases the potential for polluted stormwater runoff. ▪ The shrouded retaining walls encourage illegal dumping of small trash and property refuse, which make their way into the river.	▪ Determine a method for exploring the river through the channelized area ▪ Check for illegal dumping in the river ▪ Monitor water quality of river downstream ▪ Explore potential for ecotourism river access at the empty grocery store property

Location	Observation	Recommended Action
20. Athol Bridge 1922-Exchange Street	▪ There are signs of erosion at the storm drain pipes at the East end and the South side of the bridge adjacent to the parking lot of Pioneer Plaza. ▪ Another storm drain at the north end of the bridge on the corner also discharges stormwater into the river. ▪ The driveway design at Space Age Electronics allows runoff to drain directly down the embankment into the river.	▪ Improve stormwater management ▪ Mitigate drainage problem at Space Age Electronics
21. North Orange Road near Ellsworth Street	▪ A storm drain on North Orange Road near Mount Pleasant Cemetery shows signs of erosion on the embankment down to the river. The area is posted with a 'no dumping' sign.	▪ Investigate stormwater system
22. Victory Supermarket on South Main Street	▪ Four storm drains discharge to a brook running through culverts beneath the Victory Supermarket parking lot. The brook flows to the drinking water management area (the sewage treatment facility at the Western end of town). These can be seen near the historic marker 1737, marking the First Industries of Paqwoiag, a Gristmill and a Sawmill. Note the grinding stone set in cement. ▪ The storm drainage system in the parking lot likely feeds into these culverts. The system probably heats these waters considerably.	▪ Investigate impacts of this stormwater management system on the brook and river ▪ Determine what improvements could be designed
Millers River in Orange		
23. Wendell Dump –	▪ Closed landfill with capping problems	▪ Monitor capping problems ▪ Mitigate when necessary
24. Erving Paper Mill –	▪ Paper and solid waste debris along upland bank strewn throughout area including along railroad tracks, suspect along riverbank (located along Route 2)	▪ Clean up paper debris
25. Former Erving Paper Site	▪ appeared to be abandoned ▪ old tires in River	▪ Explore alternative use of mill site ▪ Remove old tires in the River
26. Former/inactive Highway Garage,	▪ small Riparian Buffer ▪ Debris scattered throughout Site, ▪ Sand piles with no Erosion Controls in place, although site appeared to slightly slope away from river, ▪ water hyacinth in Millers River.	▪ Clean up Debris ▪ Check status of the facility ▪ Investigate extent of Water Hyacinth and determine whether it is a problem

VI. Assessment of Water Quality Protection Measures

A. Protective Measures

One factor in determining the impacts of land use on water quality is knowledge of the controls each community places upon land uses. The level of control varies by community, and generally reflects the particular issues present in the landscape, such as particularly valuable drinking water resources or topography conducive to extensive flooding. Controls are found in the Zoning and General bylaws, the subdivision regulations and the Board of Health regulations.

Zoning and General Bylaws

Comprehensive Plans – These are community-wide planning documents that assess many aspects of the town, such as the natural resources, the economic status, the community facilities and infrastructure, the land uses, the housing characteristics, and the historic and cultural resources. The documents include recommendations and plan of action that are most appropriate to the needs of the community residents and their vision of the future for the town.

Use Districts – The community identifies the areas in town that are best suited (in their opinion) to certain land uses. Typical use district designations are Agricultural, Residential, Commercial, and Industrial.

Impervious Surface Controls – These are generally defined in the dimensional requirements of the Zoning Bylaw, and are expressed as a percentage limitation of the land area. The requirement limits how much of the land can be rendered impervious to rainwater. For example, the dimensional requirements for land use in a given use district state that no more than forty percent of the land area can be rendered impervious. If a parcel has twenty acres, and a landowner wants to build an office park, only eight acres of the land can be rendered impervious by both the office park and the parking lot. The rest of the land must permit the flow of rainwater through the ground. This control is most useful in protecting aquifer recharge areas or groundwater for private wells. These should not be confused with parking requirements, which set a minimum standard for the number of parking spaces to be provided for any given land use.

Zoning Map – This document delineates the use districts of a community, as well as protective overlay districts.

Permitted Uses – A number of controls are found in Zoning Bylaws in the form of permitted or prohibited uses. These are ordered by the Use District and let property owners know what uses are permitted by right or special permit, or are prohibited. General Bylaws and Board of Health Regulations may subject the use to further regulation or a requirement to register with permitting authorities to ensure compliance. The restrictions allow the towns to control the storage and use of toxic and hazardous chemicals and waste as well as petroleum products. Examples of regulated permitted uses are as follows:

- Commercial livestock Regulations – These serve to limit the types of livestock and the extent of livestock management that can occur in a given area. It would be used to control the impact of livestock on surface waters.
- Solid Waste Dumping – This regulation allows the town to target appropriate locations for solid waste management as well as control illegal dumping.
- Management of Junk Cars/Auto Salvage – Junk cars and auto salvage operations typically have a large number of old problem cars stored on site. Since they can leak petroleum products and other chemicals, they can present a hazard to groundwater and s8urface water. Prohibiting operation of junk yards and auto salvage businesses near waterbodies or limiting their operation can serve to protect the water quality.
- Hazardous Materials/Waste Regulations

- Hazardous Chemical Users
- Radioactive Waste
- Underground Storage Tank
- Storage of Salt/Sludge/Septage/Commercial Fertilizers/Manure

Earth Removal Regulations – These regulations require landowners or construction companies to obtain a special permit regulating removal of topsoil, loam, sand, and gravel from an area. The regulations limit the quantity of earth to be removed, and place controls on how the removal operation is conducted, to protect against erosion, excessive noise, and depletion of a needed resource.

Erosion/Sediment Control – These bylaws place restrictions on land clearing practices to protect public roads and lakes, rivers, and streams from excessive erosion and sedimentation.

Upland/Slope Protection/Regulation – Where the slope of the land becomes steep towns may impose building restrictions or prohibitions in an effort to prevent erosion. Such areas can be mapped for a community and included as an overlay in the zoning map.

Road Salt Policy – Towns can adopt strategies for the management and reduction of road salt application in sensitive areas to protect aquifers and watersheds. Often they will prohibit uncovered storage of road salt and require specific design standards for salt enclosures to protect against exposure to rainwater. These standards would include sealed flooring to prevent groundwater contamination.

Phased Growth – Often towns seek to control the growth of development by limiting the amount of development that can occur within a specified time period. The intent is to allow the town time to ensure that the proper infrastructure is in place or to plan for future community needs based on the anticipated growth in population. Typically these bylaws limit the number of building permits that can be issued in a given time period. They work best when the limits are tied to the actual capacity of the municipal infrastructure and the realistically attainable plan for its expansion to meet the demand.

Open Space (Cluster) Zoning/Development Alternative – These regulations relax the lot size dimension standards for development of single-family parcels in exchange for a set aside of open space. Ideally, the open space requirement is used as additional protection for water, wetlands, and steep slopes and can help to reduce erosion and stormwater runoff. Some communities may establish a district where they want cluster development to occur, other may encourage the developer to develop subdivisions with the principals of open space development. Communities often permit clustering of single-family homes through a special permit and a site plan review. Such regulations are found both in the Zoning Bylaw and in the Subdivision Control regulations.

Planned Unit Development – one or more lots, tracts, or parcels of land to be developed as a single entity, the plan for which may propose density or intensity transfers, density or intensity increases, mixing of land uses, or any combination thereof, and which may not correspond in lot size, bulk, or type of dwelling or building, use, density, intensity, lot coverage, parking, required common open space, or other standards to zoning use district requirements that are otherwise applicable to the area in which it is located.

Backlot Development Zoning – (Flag Lots) Generally, have the minimum lot dimension behind an existing approved lot but has access to a public road or approved subdivision road by way of a narrow strip of land. However, lots must have sufficient area so that a private well for water supply can be located without danger of contamination by a sewage system, and so that a serious drawdown of groundwater levels beyond the boundaries of the lot itself can be avoided.

Recycling Bylaw – Some towns vote to establish recycling programs in an effort to reduce the amount of solid waste dumped in their landfills each year. Recycling programs provide for collection and delivery of reusable materials through some form of assessment fee.

Overlay Protection Districts – Overlay districts are superimposed on the principal, underlying districts of the town. They are designed to protect valued resources or property for hazardous impacts by limiting or prohibit-

ing incompatible uses within the district and establishing performance standards that must be attained by land uses or developments permitted within the district.

- Water Supply/Wellhead – these zones protect public water supplies by limiting or prohibiting land uses that generate hazardous chemicals or wastes that could leach into the water supply.
- Aquifers – These zones protect the area needed for the recharge of aquifers in towns that use them for public water supplies. Typically, they prohibit activities such as underground storage tanks, landfills, junkyards, and hazardous waste facilities. They also limit the amount of land area that may be rendered impervious to groundwater recharge.
- Stream and ponds – these areas are generally buffers of land that extend from the banks of waterbodies to a distance of 100 to 500 feet, enabling the area to filter surface or stormwater runoff.
- Watersheds – This overlay protects the land area that drains into rivers and reservoirs limiting land uses to minimize pollution potential from run-off or hazardous chemicals.
- Wetlands Protection District– In addition to the Wetlands Protection Act, towns may adopt local wetlands bylaws in an effort to further protect their wetland areas. They may either be included in the zoning bylaws, limiting the uses and activities in wetland areas, or be established as a general bylaw, giving the local conservation commission regulatory control over the activities within the wetlands district, and establishing stricter design and performance standards.
- Floodplains - These districts correspond to the 100-year flood line as delineated on the Federal Emergency Management Act (FEMA) Flood Insurance Rate Maps (FIRM). They are intended to protect people and property against flood safety hazards by limiting the use of lands within the region. The limits protect both by reducing the amount of property exposed to flood risk and by preventing uses that increase impervious surfaces. These uses increase the flood potential and the flood peak an reduce the flood storage capacity.

Site Plan Review – Towns can subject larger developments that do not require subdivision review to a site plan review process, through the zoning bylaw. The site-plan review covers protection of visual and environmental, management of traffic flow, provision of water and sewer infrastructure, drainage and erosion control, and open space requirements. Towns can require analysis of impacts to water resources and the potential for pollution.

Subdivision Control Laws

Subdivision regulations under M.G.L. Chapter 41: Section 81K - GG. Designation of subdivision control law, generally follow the town's zoning bylaws. That is, subdivision regulations are established to assist Towns with additional municipal services. Generally, these regulations establish standards for roads, sewers, stormwater and erosion and sedimentation control standards during construction. In addition, towns may have requirements for filing an Environmental Impact Report that reviews potential impacts to natural resources. Approval of a subdivision may require the preservation of parks, open space and recreation areas. To assist municipalities with maintaining Community goals and objectives subdivision plans must be submitted to the municipal Planning Board. Generally this allows for municipal and abutter review prior to any development of lots not meeting the minimum density and dimension standards established in the Zoning regulations. A few examples of these plans are provided below:

- Preliminary Plan – Provides a municipality and abutters with an opportunity to resolve conflicts with the developer prior to the submission of a definitive plan.
- Definitive Plan - details stormwater drainage conveyances, road dimensions, soil erosion, loss of vegetative cover, site soils and/or other disturbances to the natural ecology of the site. The plan must also delineate all natural resources including but not limited to intermittent and perennial streams, wetlands and some may require stonewalls. The municipal Board of Health may be required to review/approve this plan for compliance with Title 5 (310 CMR 15.00) for each subdivision;
- Impact Statement – details analysis of potential environmental impacts due to changing existing land use;
- Design Standards – establishes requirements for subdivision infrastructure and may require parks, open space or other recreational amenities; and,

- Required Improvements – typically mandates that existing infrastructure (e.g., stormwater conveyances) be upgraded to meet new or improved design standards.

Often the Subdivision Regulations include a Provision for Open Space, which allows the Planning Board to require that a subdivision plan make allowance for a park or recreational area in proportion to the size of the subdivision land and the number of house lots to be created. Usually, the Open Space provision is coupled with a provision for Natural Features Preservation. This provision allows the Planning Board to prohibit the developer from disturbing such features as stone walls, trees, wooded areas, water courses, wetlands, scenic points, historic spots, and to specify design standards for their preservation.

Nearly all Subdivision Regulations include language governing Surface Drainage Regulations. Generally, these regulations are incorporated into the design standards for creation of roads in the subdivision. They can also include management of stormwater over the individual house lots that will be created. The regulations require installation of storm drains and catch basins for management of stormwater. They also specify requirements for discharge of stormwater to ground points or waterbodies, in varying degrees.

In many cases the Subdivision regulations require the submission of an Environmental Impact Statement for large subdivisions. The report must be prepared by a team of professionals, including: Civil and Traffic Engineers, Architects, Land-Use Planners, Hydrogeologists, and others. The report must specify the environmental and community impacts, unavoidable adverse impacts, potential alternatives, and corrective measures to be employed to minimize adverse impacts. Often, Site Plan Approval is made contingent upon Planning Board review of the Environmental Impact Statement.

The Board of Health ensures the quality of ground and surface water through enforcement of proper siting, construction, inspection and maintenance of septic systems and private wells. Typical setbacks for private wells include at least 100 feet up gradient from a septic system. Setbacks for septic systems from water resources and or wetlands are at least 100 feet. Although BOH may implement stricter regulations most follow guidelines outlined in 310 CMR 15.00.

B. Municipal Assessment of Protection Measures

One approach to managing nonpoint source pollution throughout the watershed is to evaluate the current zoning bylaws and subdivision regulations for each community. Dimensional Requirements will determine the lot size and frontage for each new house lot created and, taken cumulatively, will indicate the land consumption pattern and the potential creation of new roads, as summarized in the discussion of the buildout analysis. The greater the lot size and frontage requirement, the more land consuming the development pattern will be, and the greater the infrastructure burden to the community will be. Conversely, the smaller the lot size, the greater the percentage of land area that is rendered impervious. When coupled with parking regulations for each land use the impervious surface equation becomes magnified. This is mainly an issue where the land uses are more urbanized. The following zoning assessment does not consider the parking standards. A more in-depth analysis of the zoning is recommended. Table VI-1 lists the dimensional requirements for each community in the watershed.

Each community controls for uses and environmental threats a little differently than its neighbors. Some simply prohibit uses that pose an environmental threat. Others must manage the threat while allowing for the land use. In varying degrees, the communities in the watershed recognize the value of their water resources and have established overlay districts to protect wetlands, streams and ponds, groundwater sources, aquifers, and watersheds for public water supplies. Each community has established a Floodplain district based upon the Flood Insurance Rate maps of the Federal Emergency Management Agency. In these districts anything that has the potential to pose a threat to the public in the event of a flood is prohibited, or permitted by Special Permit if it can be professionally demonstrated that the use will not have an impact. Table VI-2 summarizes the Watershed Management Growth Control Measures in place in each community. In the Table, Yes indicates that there is a provision or mention listed, No indicates that no mention of the item is listed.

Table VI-1: Dimensional Requirements Specified in Local Zoning for Millers River Watershed Towns

Residential Zoning	Minimum Lot Size	Frontage	R.O.W.	Units per Lot
Ashburnham				
Residential (RA)				
Single Family	45,000	150	40	1
Residential (RB)				
Single Family	60,000	200	40	1
Water Supply Protection (WSP)				
Single Family (RA District)	90,000	150	40	1
Single Family (RB District)	90,000	200	40	1
Athol				
Multi-Family Residential (RA)				
Single Family	8,000	65	50	1
Two Family	12,000	65	50	2
Three Family	16,000	65	50	3
Four Family	24,000	65	50	4
Medium Single-Family Residential (RB)				
Single Family	10,000	70	50	1
Rural Single-Family Residential (RC)				
Single Family	44,000	160	50	1
Gardner				
Single-Family Residential I (R1)				
Inside Water Supply Protection Overlay	87,120	100	50	1
Outside Water Supply Protection Overlay	12,500	100	50	1
Rural Residential II (R2)				
Public Water & Sewer				
Inside Water Supply Protection Overlay	87,120	125	50	1
Outside Water Supply Protection Overlay	40,000	125	50	1
No Public Water & Sewer				
Inside Water Supply Protection Overlay	130,680	150	50	1
Outside Water Supply Protection Overlay	60,000	150	50	1
General Residential III (R3)				
Single Family				
Inside Water Supply Protection Overlay	87,120	75	50	1
Outside Water Supply Protection Overlay	8,000	75	50	1
Two Family	12,000	75	50	2
Industrial I (I1)				
Inside Water Supply Protection Overlay	87,120	80	50	1
Industrial II (I2)				
Inside Water Supply Protection Overlay	87,120	150	50	1
Hubbardston				
Residential Agricultural (RA)				
Single Family	80,000	200	50	1
Two Family	80,000	200	50	2
Town Center (TC)				
Single Family	80,000	200	50	1
Two Family	80,000	200	50	2
Commercial (C)				
Single Family	80,000	200	50	1
Two Family	80,000	200	50	2
Light Industrial (LI)				
Single Family	100,000	300	50	1
Two Family	100,000	300	50	2
Phillipston				
Residential Agricultural (RA)	80,000	200	40	1
Commercial Industrial (CI)	80,000	200	40	1
Recreation (REC)	80,000	200	40	1
Royalston				
Residential (R)				
With Sewers:				
Single Family	21,780	75	50	1
Two Family	21,780	75	50	2
Without Sewers:				
Single Family	43,560	100	50	1
Two Family	43,560	100	50	2

Residential Zoning	Minimum Lot Size	Frontage	R.O.W.	Units per Lot
Royalston (Cont.)				
Historic Residential (HR)				
Single Family	43,560	125	50	1
Two Family	43,560	125	50	2
Rural Residential and Agricultural (RA)				
With Sewers:				
Single Family	43,560	125	50	1
Two Family	43,560	125	50	2
Without Sewers:				
Single Family	130,681	300	50	1
Two Family	130,681	300	50	2
Templeton				
Unzoned				
Single Family	43,560	150	40	1
Two Family	43,560	150	40	2
Business	43,560	150	40	
Westminster				
Residential I (R1)				
Single Family	50,000	150	54	1
Two Family	50,000	150	54	2
Residential II (R2)				
Single Family	60,000	175	54	1
Two Family	60,000	175	54	2
Residential III (R3):				
Single Family Only	86,000	200	54	1
Winchendon				
Rural Residential (R1)				
Single Family	87,120	200	50	1
Rural Suburban Residential (R2)				
Single Family	60,000	175	50	1
Suburban Residential (R3)				
Single Family	43,560	150	50	1
Two Family	43,560	150	50	2
Neighborhood Residential (R4)				
Single Family	21,780	125	50	1
Neighborhood Business (C2)				
Single Family	22,500	150	50	1
Erving				
Village and Rural District				
With Utilities				
(1/4 mile sewer line buffer, access to Rtes. 2, 2A and 63)				
Residential Uses -				
1 Family	20,000	115	40	1
2 Family	27,000	115	40	2
3 Family	34,000	115	40	3
4 Family	41,000	115	40	4
Commercial	20,000	115	52	
Industrial	20,000	115	52	
With Utilities				
(1/4 mile sewer line buffer, access to North Street)				
Village Residential Uses -				
1 Family	20,000	115	40	1
2 Family	27,000	115	40	2
3 Family	34,000	115	40	3
4 Family	41,000	115	40	4
WITHOUT UTILITIES				
Large lot Residential Uses -				
1 Family	30,000	140	40	1
Orange				
Village Residential / Commercial				
Residential- One Family	10,000	50	NA	1
Residential- Two Family	10,000	50	NA	2
Residential- Three Family	20,000	50	NA	3
Residential- Four Family	30,000	50	NA	4
Commercial	10,000	50	NA	
Industrial	10,000	50	NA	

Residential Zoning	Minimum Lot Size	Frontage	R.O.W.	Units per Lot
Village Residential				
Village Residential- One Family	10,000	50	NA	1
Village Residential- Two Family	10,000	50	NA	2
Village Residential- Three Family	20,000	50	NA	3
Village Residential- Four Family	30,000	50	NA	4
Residential / Commercial				
Residential- One Family	43,560	100	50	1
Residential- Two Family	43,560	100	50	2
Residential- Three Family	83,560	100	50	3
Residential- Four Family	123,560	100	50	4
Commercial	43,560	100	50	
Industrial	43,560	100	50	
Residential				
Residential- One Family	43,560	100	50	1
Residential- Two Family	43,560	100	50	2
Residential- Three Family	83,560	100	50	3
Residential- Four Family	123,560	100	50	4
Residential within MDC Buffer				
Residential- One Family	87,120	100	50	1
Residential- Two Family	174,240	100	50	2
Residential- Three Family	261,360	100	50	3
Residential- Four Family	348,480	100	50	4
Rural Residential				
Rural Residential -One Family	43,560	200	50	1
Rural Residential within MDC Buffer				
Rural Residential -One Family	87,120	200	50	1
Warwick				
Residential - Agriculture				
99.1% One Family	87,120	300	49.212	1
0.9% Two Family	174,240	300	49.212	2
Wendell				
Rural Residential and Agriculture				
99% One Family	130,680	200	59.054	1
1% Two Family	130,680	200	59.054	2

Source: Zoning By-Laws for Ashburnham, Athol, Erving, Gardner, Hubbardston, Orange, Phillipston, Royalston, Templeton, Warwick, Wendell, Westminster, and Winchendon

TableVI-2: Local Water Quality Protection By-laws and Regulations in the Montachusett Region

Zoning and General Bylaws and Subdivision Regulations	Ashburnham	Athol	Gardner	Hubbardston	Phillipston	Royalston	Templeton	Westminster	Winchendon
Comprehensive Plans	Yes	No	Yes	No	No	Yes	No	No	No
Use Districts	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Impervious Surface Controls	Yes	No	No	Yes	No	Yes	No	No	No
Zoning Map	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Commercial livestock Regulations	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes
Solid Waste Dumping	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes
Management of Junk Cars/Auto Salvage	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Hazardous Materials/Waste Regulations	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Hazardous Chemical Users	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Radioactive Waste	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Underground Storage Tank	Yes	No	No	Yes	No	Yes	No	No	No
Storage of Salt/Sludge/Septage/Commercial Fertilizers/Manure	Yes	No	No	Yes	No	Yes	No	Yes	Yes
Earth Removal Regulations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Erosion/Sediment Control	Yes	No	No	Yes	No	No	No	No	No
Upland/Slope Protection/Regulation	No	No	No	No	No	No	No	No	No
Road Salt Policy	Yes	No	No	Yes	No	No	Yes	No	Yes
Phased Growth	Yes	No	Yes	Yes	No	No	No	No	No
Open Space Residential Design/Cluster Zoning	No	No	Yes	No	No	Yes	No	No	No
Planned Unit Development	No	No	No	No	No	No	No	No	No
Backlot Development	No	No	Yes	Yes	No	Yes	No	No	Yes
Recycling Bylaw	Yes	No	No	No	No	No	No	No	No
Groundwater Protection/Private Well Regulations	No	No	No	Yes	No	No	No	Yes	Yes
Water Supply/Wellhead Protection District/Regulations	Yes	Yes	Yes	No	No	No	No	No	Yes
Aquifer Protection District/Regulations	N/A	No	No	Yes	No	No	No	No	No
Stream and pond Protection/Regulations	No	No	No	No	No	No	No	No	No
Watershed Protection District/Regulations	Yes	No	No	No	No	No	No	No	No
Wetland Protection District or Wetland Exclusion	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes
Edge District/Wetland Buffer beyond Protection District	No	No	No	No	No	Yes	No	No	No
Floodplain Protection District/Floodplain Use Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stormwater Regulation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Residential Septage Management	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Commercial Sewage Disposal or Treatment Plants	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes
Title V Supplement	No	No	No	Yes	Yes	No	Yes	Yes	No
Environmental Performance Standards: Subdivisions, Cell Towers	Yes	No	No	Yes	Yes	Yes	No	No	No
Provision for Open Space	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Natural Features Preservation	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes
Surface Drainage Regulations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Site Plan Review	Yes	No	Yes	Yes	No	Yes	No	No	No
Site Plan Approval Required	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Environmental Impact Report Requirement	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No
Other Growth Limits	Yes*	No	No	No	No	No	No	No**	Yes†

Sources: Town General and Zoning Bylaws, Subdivision and Board of Health Regulations; *Watershed Protection for Towns: Analysis of Existing Bylaws*, Nov 1993, Ralph R. Wilmer, AICP, McGregor & Shea, P.C., Boston, MA and Division of Watershed Management, Metropolitan District Commission.

* Growth Limitation Per Development

** Sewer Moratorium imposed by Fitchburg.

† Ceiling on Residential Building Permits.

TableVI-3: Local Water Quality Protection By-laws and Regulations in Franklin County Communities

	Erving	Northfield	Montague	Orange	Warwick	Wendell
Comprehensive Plans	No	No	Yes	Yes	n/a	n/a
Use Districts	Yes	Yes	Yes	Yes	Yes	Yes
Impervious Surface Controls	No	Yes	No		Yes	Yes
Zoning Map	No	Yes	Yes	Yes	Yes	No
Commercial livestock Regulations	No	No	No		Yes	Yes
Solid Waste Dumping	No	No	No			Yes
Management of Junk Cars/Auto Salvage	Yes	Yes	Yes	Yes	Yes	Yes
Hazardous Waste/ Materials Regulations	Yes	Yes	Yes	Yes	Yes	Yes
Hazardous Chemical Users	No	No	No		Yes	Yes
Radioactive Waste	Yes	Yes	Yes		Yes	Yes
Underground Storage Tank	No	Yes	Yes	Yes	Yes	Yes
Storage of Salt/Sludge/Septage/Commercial Fertilizers/Manure	No	Yes	Yes	Yes	Yes	Yes
Earth Removal Regulations	No	Yes	Yes	Yes	Yes	Yes
Erosion/Sediment Control	Yes	Yes	Yes	Yes	Yes	Yes
Upland/Slope Protection/Regulation	No	No	No	Yes	Yes	
Road Salt Policy	No	No	No			Yes
Phased Growth	No	No	No	No	Yes	No*
Open Space (Cluster) Zoning/Open Space Development Alternative	No	Yes	Yes	Yes	Yes	Yes
Backlot Development Zoning	Yes	Yes	Yes			Yes
Recycling Bylaw	Yes	No	No	No	No	No
Groundwater Protection/Private Well Regulations	No	Yes	No	Yes	Yes	Yes
Water Supply/Wellhead Protection/Regulations	No	Yes	Yes	Yes		Yes
Aquifer Protection District/Regulations	N/A	N/A	N/A	Yes	No	Yes
Stream and pond Protection/Regulations	Yes	Yes	No			Yes
Watershed Protection District/Regulations	No	No	No	Yes	No	Yes
Wetland Protection District	No	No	No	Yes		Yes
FloodPlain Protection District/Floodplain Use Controls	Yes	Yes	Yes	Yes	No	Yes
Subdivision Control Laws						
Stormwater Regulation	Yes	Yes	Yes	Yes	Yes	Yes
Residential Septage Management	Yes	Yes	Yes	Yes		Yes
Commercial Sewage Disposal or Treatment Plants	No	Yes	Yes	No	Yes	No
Title V Supplement	No	No	No	Yes		Yes
Environmental Performance Standards for Subdivisions, Cell Towers	No	Yes	Yes	Yes	Yes	Yes
Provision for Open Space	Yes	Yes	Yes	Yes	Yes	Yes
Natural Features Preservation	Yes	Yes	Yes	Yes	Yes	Yes
Surface Drainage Regulations	No	Yes	Yes		Yes	Yes
Site Plan Review	Yes	Yes	Yes	Yes	Yes	Yes
Site Plan Approval Required	No	Yes	Yes	Yes	n/a	Yes
Environmental Impact Report Requirement	No	Yes	Yes	No	Yes	Yes
Other Growth Limits	No	No	No	Yes	n/a	n/a

Sources: Town General and Zoning Bylaws, Subdivision and Board of Health Regulations; *Watershed Protection for Towns: Analysis of Existing Bylaws*, Nov 1993, Ralph R. Wilmer, AICP, McGregor & Shea, P.C., Boston, MA and Division of Watershed Management, Metropolitan District Commission

* There was a phased growth bylaw, but it may have been deleted from the bylaws.

Worcester County

Ashburnham

The Town of Ashburnham grew rapidly from 1980 to 1990. Its population increased 33% in those years, from 4075 to 5433. Growth slowed considerably from 1990 to 2000, increasing by only 113 (2%). MISER forecasts population gains of 917 people by 2010. Ashburnham's Zoning bylaws provide a number of basic growth management controls, but they are limited in encouraging or allowing creative or flexible development approaches. There are no provisions for cluster or backlands development or zoning incentives to build in or near existing village centers and minimum lot size requirements are high throughout the town (45,000 to 60,000square feet, with the exception of a mere 14 undeveloped acres zoned "Business," which allow construction on 25,000square feet lots). The General bylaws include regulations for the protection of wells the municipal sewer collection disposal system, restriction on water use, and provisions for recycling.

There are currently provisions in the Zoning By-laws for site plan review, water supply protection, wetland and watershed protection, and development rate limitation. The Schedule of use regulations covers six zoning districts and is quite comprehensive.

Site plan approval is required for all developments except one- and two-family homes and agricultural uses. The town can use the bylaw to control undesirable consequences of growth such as traffic, parking, and water pollution. It is used for certain commercial/industrial development, but the bylaw could have stronger language.

The Zoning Bylaws pay special attention to water protection. A Wetlands and Watershed Protection District protects these areas by restricting and prohibiting uses that have the potential to generate non-point sources of pollution discussed in this Assessment. It is a comprehensive regulation and very effective in its language. A Water Supply Protection Overlay District protects the watershed of the Upper Naukeag Lake surface water supply. The district restricts certain uses (e.g., salting roads, fertilizer application) and requires a special permit for any development creating more than 15% or 2,500 square feet of new impervious surface. A Floodplain Overlay district corresponding to the Ashburnham Flood Insurance Rate Maps, Flood Boundary and Floodway Maps defines an area subject to local and state code restrictions, subdivision standards, and health regulations specified in the Zoning Bylaws. Maps with overlay districts compliment the water protection sections of the code.

There are no specific regulations of agriculture except that crop farming and livestock management are subject to obtaining a special permit in the Water Supply Protection District and in the three residential districts on parcels of less than five acres.

A development rate limitation is triggered when more than 50 new dwellings have been permitted with a two-year period, but only applies to larger projects (greater than 8 dwellings on contiguous, commonly-held lots). It is un-clear from the bylaw exactly how this rate limit applies to different projects (e.g., a "first-come, first-served" waiting list? a rationing of permits to pending developments?).

The Development Rate Limitation shows the Town is concerned and aware of the growth it is experiencing, however, limits are not necessarily the only approach.

- Creating a Master Plan will redefine Ashburnham's goals and objectives for land policy and chart a course for the future. With a Master Plan, more appropriate and effective zoning can be developed which relates to a grander vision.

- Adopting an Open Space Residential Design Bylaw can help the town preserve open space and protect sensitive watershed lands while assisting with its affordable housing goals. However, at the annual town meeting in 1992, voters rejected a proposal to change the zoning code to allow cluster zoning. The bylaw was introduced as "Open Space Development" and promised to permanently preserve land as open space. Chairperson of the Board of Selectman, Janet Dolder, explained that the bylaw was rejected because the townspeople didn't want any form of development, not even clustered. There was strong voter sentiment that the bylaw would encourage more growth.

- Better education on the costs and benefits of cluster zoning relative to the costs community services of would help such a measure pass at town meeting. Town-wide workshops can be held to sell this message to Ashburnham residents. Use of build-out scenarios in planning forums can help to illustrate the advantages of cluster zoning.

- In its efforts to preserve its rural character, Ashburnham should focus on ways to further promote agriculture and limit farmland conversion into residential uses. Utilizing recommendations made in the Greater Gardner Sustainable Growth Management Plan, town officials can contact local farmers and act before land is sold to developers.

Athol

Athol has exhibited relatively minimal growth over the last two decades. Between 1980 and 1990 the town population grew at a rate of 8%, from 10,634 to 11,451, increasing by 817. Since then the population has actually declined by 152, dropping to 11,299, at a rate of –1%. At present, the Town is developing a Master Plan to help guide its future. The plan is strongly focused on the environmental resources of the Town and its important water resources are highlighted. Recommendations for changes to its zoning bylaws will be an important outcome of the planning process.

Fully 89% of the Town of Athol is zoned as a Rural Single Family Residential District. Nearly all of the 3,700 acres of permanently protected open space in the Town is in this district, representing 17 percent of the total land area of the town and 19 percent of the district. A small Industrial District is located east of the center of town. Junk Car and Auto Salvage businesses are only allowed to operate in this district under Special Permit. Users of Hazardous Chemicals, and handlers of Hazardous Materials and Wastes are heavily regulated by the State and Federal governments and are permitted in the Industrial district. The zoning allows Earth Removal projects by Special Permit in all but the Central Commercial and Neighborhood Commercial districts. Any earth removal projects must be in compliance with the provisions of the Floodplain District.

Athol has an Overlay Groundwater Protection District that originally consisted of a half-mile radius of each wellhead until the Zone II recharge areas were designated for the Tully Wellfields and the South Street Well. The delineations now represent the district.

The Floodplain Protection District, based upon the Flood Insurance Rate Maps and the Flood Boundary and Floodway Maps, protects the public health, safety and general welfare, preserves the flood control characteristics and flood storage capacity of the floodplain, and protects the ground water table and water recharge areas within the floodplain. No structures, fill, or storage of materials or equipment are permitted there. Prohibited uses include:

- Acetylene, cyanide or oxygen manufacture;
- Asphalt manufacture;
- Chlorine or Bleaching Manufacture;
- Creosote;
- Distillation of Coal or Wood
- Explosives; fireworks, or ammunition
- Fertilizer manufacture
- Fumigation plants;
- Glue or size manufacture from fish or animal offal;
- Gypsum, cement, or plaster production;
- Incineration, reduction or dumping of offal; garbage or refuse on a commercial basis (Except where controlled by the Town of Athol)
- Junk yard, junk storage scrapping of autos and parts and the salvage thereof
- Linoleum manufacture
- Match Manufacture
- Storage, collection, treatment, burial, incineration, or disposal of radioactive wastes, including but not limited to low level wastes;

The Design Standards of the Subdivision Control Regulations provide for both utility easements and stormwater easements or drainage rights-of-way where the subdivision is traversed by a water course, drainage way, channel, or stream. Storm water sewers are to be designed to the capacity needed for the 20-year frequency storm and water velocities between 2 and 10 feet per second. While this may be sufficient on a daily basis, in the event of the 100-year storm, the system may not have the capacity to manage the water flow. The regulations also specify that the Department of Public Works determines the design of the sewerage system. In addition, the regulations give the Planning Board discretion to require a subdivision plan to include open space suitable for playground or recreation purposes. The burden of Preservation of Natural Features is placed upon the developer and is subject to Planning Board Approval. Drainage controls are placed upon the subdivision under required improvements for an approved subdivision.

There is no specific provision for Site Plan Review in the language of the Zoning Bylaw or the Subdivision Control Regulations, however, no subdivision can occur until the Planning Board approves a Definitive Plan. The regulations do not specify a requirement for an Environmental Impact Statement. No provision exists for alternative design of subdivisions such as Open Space Residential Design or Cluster Zoning, nor is there a provision for Backlot Development.

The documents do not have provisions for the control of impervious surfaces (beyond the minimum requirements for parking spaces per use), or for management of commercial livestock. Solid Waste Dumping is specifically under the Floodplain Protection District, but not mentioned in discussions of other zoning districts. There is not restriction listed for underground storage tanks or storage of salt, sludge, septage, commercial fertilizers, or manure. The also do not deal with Erosion Control or Upland/Slope Protection. The Road Salt Policy is set internally at the Department of Public Works

Gardner

Gardner is the largest of the three cities in the region, with a population of 20,770. Gardner experienced moderate growth, at 12.4% between 1980 and 1990, an increase of 2,225 people. In raw numbers this town added the most people of any town in the watershed during that decade. Since 1990, the growth rate has slowed and the population increased to 645 (3%) by the year 2000. The growth did not occur in the downtown area, however, but rather in the outlying fringe areas. This pattern of development is harmful for the city's economic, social and environmental vitality. The city has recognized this and has adopted positive growth management tools within its borders, and formed a Greater Gardner 2000 Partnership with its neighbors, to develop a vision for the Greater Gardner region.

The Greater Gardner 2000 Partnership produced an Economic Development Strategy in November of 1995. The comprehensive document addresses the issues of growth through 1) more mixed-use development, 2) revising and stream-lining the permitting process, 3) conserving land and 4) developing a 21E environmental strategy (remediation of brownfields). However, no follow-up funding has been allocated and many of the planned initiatives have not been pursued. The Greater Gardner communities have applied for funding to conduct a sustainable growth plan through the Massachusetts Executive Office of Environmental Affairs.

Gardner's bylaws contain virtually all of the growth management protections: a water supply protection district, a growth phasing control requiring scheduled development, and site plan review requirement for large projects (i.e., more than 7,500 interior square feet of space, more that 30 parking spaces, and/or more than 500 new vehicle trips/day generated). The bylaws allow cluster developments by special permit on parcels of five acres or more, provided no more units are allowed than by conventional subdivision and that a minimum of 40% of the area is protected as open space. An allowance for "irregular shaped lots" encourages backlands development where ANR lots are likely, providing an alternative pattern that is less consumptive of frontage and more likely to fit aesthetically with scenic roadways.

Lot sizes are small within the boundaries of the established neighborhoods and downtown areas (nearly 1,000 acres of developable land), providing possible opportunities to develop and infill these locations rather than create new subdivisions or ANR lots in the rural parts of the town. In addition, allowance of mixed uses and

shared parking in these zones, as well as the potential designation of special development overlay districts for economic revitalization all provide additional downtown incentives.

A Development Overlay District encourages redevelopment options in the Industrial-I and Commercial-I Districts where they exhibit impacts of economic stress. The district specifies a select group of permitted uses by right designed to enhance quality of life for area residents. Minimum lot size is only 5,000 sq ft. and there are no minimum frontage or front setback requirements. In comparison, the minimum lot size in a conventional Commercial I District, without the overlay, is 10,000 sq ft, the frontage requirement is 80 ft, and the setback is 10 ft. This measure met initial resistance, but it was successfully used to redevelop an old industrial site for retail use. The placement of a CVS Pharmacy onto a site zoned for industrial uses, yet within the Development Overlay District, demonstrated the importance of such a district.

The Zoning provides for a Water Supply Protection District that overlays the primary and secondary recharge areas of groundwater and watershed areas of water supply reservoirs.

Cluster zoning is allowed by special permit in Rural Residential and General Residential Districts. Most of the dimensional requirements for conventional subdivisions apply to cluster developments. Forty percent of the whole parcel, exclusive of wetlands or land set aside for roads and parking, becomes permanent open space. Success of the bylaw has been limited. Of four development projects approved for cluster-style construction, only one was successfully built and open space was preserve. One developer later modified his plans for a more conventional design. Construction began on another project, but mid-way through the design was reverted back to a conventional layout. The fourth project was never built. According to Gardner Planning Director Robert L. Hubbard, the bylaw does not offer clear guidelines for developers and the Planning Board does not look favorably upon cluster development.

Site Plan Review is required for all large-scale structures (greater than 7500 sq ft) except single-family detached dwellings. The review process scrutinizes plans for uses and structures that may significantly impact traffic, municipal buildings, and public services and utilities, environmental and design quality, community economics, and community values in the City. If certain criteria are not met, the Planning Board will request a Development Impact Statement from the applicant.

The Town of Gardner has adopted many implementation tools and is seeking ways to better plan for growth and its consequences. Some useful approaches include:

- Creation of a Community Growth Plan that reflects the Town's growth issues and goals, substantiates planning efforts with background data and analysis, and provides a vision for the future building upon the work of the 1995 Economic Development Strategy.
- Due to the lack of success of the cluster development ordinance, a re-examination of the language of the ordinance should be a priority for Gardner. A comparison of success stories across Massachusetts and the country and the ordinances in place in these cases should provide useful guidance for improving the language.
- Downtown redevelopment measures should also be a priority. The challenge for Gardner is to concentrate its new growth into its urban core while protecting open space in outlying areas. The best way to achieve this goal is to offer incentives for development to occur downtown. Embracing the recommendations of this plan by pursuing brownfields redevelopment, offering incentives for siting in areas already serviced by infrastructure and streetscape improvement programs will focus new growth into the downtown area and help the City of Gardner to thrive.
- While downtown redevelopment is important, the proximity of downtown core contributes significantly to non-point sources of pollution to the Otter River watershed. Redevelopment efforts should include a sound plan managing impacts from stormwater runoff, impervious surfaces, and land uses.
- Employing performance zoning as part of the City's zoning code would allow more flexibility in the types and variety of development. Establishing a performance-zone district would allow the city to better control pollution, traffic and other nuisances while allowing a mixed-use vibrant urban district to flourish.

Hubbardston

For the past two decades, Hubbardston has consistently seen the highest growth rates in the region, practically doubling it population every ten years. From 1980 to 1990, the population increased from 1,797 to 2,797, a change of 1,000 people and a rate of increase of 56% in ten years. From 1990 to 2000, the population increased from 2,797 to 3,909, an increase of 1,112, and a rate of increase of 40%. Development in Hubbardston has followed a pattern of conventional subdivisions and ANR construction. The Town lacks water and sewer services and so it has adopted a policy of a minimum of two acres per lot with a frontage requirement of 200 feet. This traditional zoning treatment leads to a consumptive sprawling growth pattern. The area of the Town within the Millers River Watershed is zoned for single- and two- family residential and agricultural uses.

The Town's Zoning Bylaws provide for several growth management protections, including an Aquifer Favorability Protection District, Site Plan Review, and subdivision phasing. The Town has also adopted a General Wetlands By-Law to control activities that affect wetlands. The bylaw does not provide for cluster or back-lot development, or village center zoning incentives to encourage alternative development patterns, however, under the Subdivision Regulations, the Planning Board can require a plan to show a park of sufficient size to allow for a playground or other recreational purpose. Such a space would be equal to one acre of land for every 20 single family dwelling units. For commercial or industrial subdivision the size of the park would be equal to 3 times the floor area of the buildings.

Site plan review is required for all special permit uses, and detailed "environmental and community impact" analyses are required for all large developments, defined as more than 5,000 square feet of interior space. The Impact Analysis covers environmental impacts on Air, Water and Noise Pollution, soils compatibility and erosion control, wildlife habitat and rare plant and animal species, and water demand and sewage disposal on groundwater aquifers, as well as impacts on public services.

An Aquifer Favorability Protection District restricts uses within the municipal water supply recharge area as defined on a map entitled Aquifer Areas dating back to 1988. The district prohibits uses that are incompatible with water quality control and it limits the amount of a lot that can be rendered impervious to 25%. A Floodplain District prohibits building, dredging and filling within the areas designated on the Flood Insurance Rate Maps, in an effort to protect against flood damage and to preserve and maintain the water table and water recharge areas in the town.

A subdivision-phasing requirement limits the number of new units in any one particular subdivision to 15 (or 12.5%, whichever is greater) within a 12-month period, regardless of the overall development rate for the town. This bylaw balances the rate of residential development with the ability of the Town to provide public services to the developments and the Town.

A "Town Center" zoning district prohibits mixed uses such as retail stores and restaurants, and requires two-acre lots. It is intended to preserve the agrarian residential character of the Town Center. The Zoning provides for a Commercial district along Route 68, which will encourage more strip-mall/car-oriented development. This zone has the potential to erode the vitality of the town center by relocating the focus of daily activity, however, the zone is a natural extension of the Town Center northward.

The bylaw makes no provision for Open Space Residential Design or cluster zoning, nor do the subdivision regulations specifically discuss septic management. These area areas the town may want to consider clarifying in future drafts of their bylaws and regulations.

Phillipston

The population of Phillipston is relatively small compared to many of the communities in the watershed. From 1980 to 1990, the Town experienced significant growth at a rate of 56%, increasing from 953 in 1980 to 1,485 in 1990. Since then, the growth rate has slowed considerably dropping to 9%. Between 1990 and 2000 the population increased by 136, to a total of 1,621. The character of the town is marked by its appeal as a recreation destination.

The Zoning bylaws are limited for growth control, however the Town recently adopted a General Wetlands Protection By-Law that protects wetlands, water resources, and adjoining lands by controlling uses that might have significant impact on water supplies, groundwater, flood control, erosion and sediment control, aquaculture, wildlife and rare species habitat, agriculture and recreation values. The town is exercising its Home Rule authority to adopt stricter standards and procedures than those of the Massachusetts Wetlands Protection Act in recognition of the value of its rich water resources. The By-Law gives a broad definition of permitting and enforcement authority to the Conservation Commission.

A majority of the town (63.3%) is residentially zoned and requires large 2-acre lot sizes since the town has no sewer services. Frontage requirements are considerable, ranging from 200 feet for single- family dwellings, to 400 feet for duplexes, and 600 feet for multi-family dwellings. A large commercial zone overlays the Four Corners area, following Routes 2, 2A, and 202 and bisecting the town, encompassing an area of almost 2,300 acres of developable commercial land. A commercial district this large has the potential to encourage piecemeal and haphazard sprawl development, with little attention to infrastructure planning or coordination with existing development. This commercial zone virtually surrounds a Recreation Zone, which was created to protect the Phillipston Reservoir, Reservoir Number 2, and Bates Power Reservoir on the west side of town. The Bylaw designates another Recreation district, consisting of large areas around Queen Lake. The Recreation Zones allow one- and two-family homes, churches and schools, parks, campgrounds, and golf courses by right.

No provisions exist for cluster or backlands development, village center development, site plan review, or water resources protection overlays.

Royalston

Growth in Royalston for the past two decades has been slight, compared with communities to the east, due to its rural nature and the limits of transportation access to the town. Between 1980 and 1990 the population increased by only 192, however, this small number represents a 20% increase over the small population of 955. From 1990 to the year 2000 the population increased from 1,147 to 1,254, an increase of 107 people and a rate of increase of 9%.

Despite its rather simple zoning scheme (only three districts, all of which are residential), Royalston's bylaws provide a number of growth management provisions, including a wetland protection district; site plan review and "large development review" requirements; cluster development; flexible development (i.e., shifting dimensional requirements between lots for small projects, which may occur as of right); and backlands development (i.e. "interior lot development," to protect scenic byways and agricultural land).

Since virtually no commercial or industrial uses are allowed anywhere in the town, it is unlikely than any new development could create mixed-use districts. But the uses most likely to contribute tow water contamination are not permitted.

Minimum lot size requirements are large in the vast majority of the town: over 98% of the undeveloped land requires at least one acre for new development, and much of it requires two acres. No zoning provisions are in place to provide significant incentives for village center development.

Templeton

Population growth in Templeton has been steady at 6% per decade for the past two decades. Between 1980 and 1990 the town added 368 people, increasing from 6,070 to 6,438. By the year 2000, the population had increased by another 361 people to 6,799.

Templeton's bylaws provide few requirements to assess the potential impacts of development, and no incentives or provisions for more flexible or compact development patterns. The town has no established zoning district and town-wide the minimum lot size requirement is one acre. The bylaws provide for a water supply protection district, but the town has a few supplementary Board of Health regulations. There is a provision prohibiting out of town residents from using the Templeton Landfill on Route 202, and the bylaws have a provision regarding junk cars and auto salvage businesses. Aside from these provisions, the bylaws do not regulate development at

all. There is no specific regulation or prohibition of hazardous materials management, hazardous chemicals users or transporters, or storage of potential pollutants.

The "Zoning" section of the general bylaws contains dimensional requirements and requires special permits for some uses, but does not constitute true zoning in that it does not divide the town into distinct districts with different allowed uses. Without the framework of a zoning bylaw and map, none of the more creative growth management provisions can even be attempted here.

Templeton's location on the Otter River affords the Town a significant opportunity for environmental preservation, and its valuable groundwater resources should be protected. The Town should be advised to consider developing a formal zoning bylaw, addressing many of the water protection concerns discussed in this document.

Westminster

In the past twenty years, Westminster has been experiencing significant population growth and a rapid loss of open space. From 1980 to 1990, the population grew by 1,052, from 5,139 to 6,191, a growth rate of 20%. From 1990 to 2000, the growth rate slowed to 12%, as the population grew by another 716 people, to 6,907. Growth related to the Wachusett Mountain ski area is of great concern to Westminster residents and officials, since skier attendance at the mountain has increased to an average annual rate of over 500,000 visits.

Environmental and growth management provisions in the By-laws of Westminster include a Wetland Protection District, supplementary Board of Health regulations concerning groundwater and water supply, and a fairly aggressive new development rate limitation of no more than 8 contiguous lots in one year; no more than 10 new units per developer per year. The zoning bylaw also provides for cluster development on lots larger than 20 acres, by special permit. The provision for cluster zoning has only been utilized once so it success is undetermined.

No provisions exist to provide the necessary incentives to channel new residential growth into the existing town centers and developed areas. Although the C-II (Neighborhood) and C-III (Downtown) districts have low minimum lot size requirements, neither permits new residential uses under current zoning. Furthermore, these districts are small, with virtually no remaining undeveloped land. As a result, developers seeking to construct new units must build in the residential districts, with minimum lot size requirements of one acre and up—and there are over 13,000 acres of undeveloped land in this category. No provisions exist to encourage backlands development, either, and therefore much new development is likely to be ANR frontage development along existing roadways.

The town would be well-advised to adopt a standard site plan review requirement for all new large developments, requiring detailed impact statements and consideration of preferred alternatives. In addition, it is unclear from the zoning map and bylaw text exactly how the wetland protection district has been designated, or even how it differs in operation from the floodplain district. This confusion should be cleared up, preferably through an inventory of sensitive wetland areas conducted by the conservation commission and/or local groups and a discussion of appropriate controls for these areas.

There is currently a sewer moratorium in place by the Board of Health and the Sewer and Water Commission. Chairperson of the Planning Board, Mr. Vincent Jamieson, calls this moratorium, "the best kept secret in regulating growth." By requiring new development to use sewer if septic is not feasible, and at the same time not permitting new hook-ups, the town is stifling growth.

Westminster has been working on a Strategic Plan for Economic Development to guide growth and development in the town. An Economic Development Strategy was prepared for the Westminster Local Partnership in November 1995.

To better manage growth, Westminster officials developed an Economic Development Strategy to address growth issues in town. The 1995 report calls for encouraging agriculture, beautifying town borders and entry points, identifying significant rural streetscapes, developing a preservation plan, developing a Community Master Plan, and altering the Zoning By-laws. Specifically, the plan calls for zoning changes that would 1) create a

downtown business district, (most of the buildings in the downtown do not comply with current zoning regulations) 2) create industrial areas, 3) require a site plan review for commercial and industrial development, 4) create a design review board. These homegrown goals and objectives are the key to successfully managing growth in Westminster.

Environmental resources are not fully protected. The zoning bylaws include a section on wetlands and refer to a map that was never created. The town should develop better water protection bylaws and take a more holistic approach to environmental protection. Westminster has recently completed a draft Master Plan for the town. This plan will help to define direction for Westminster as it enters the next millennium.

Winchendon

Like Gardner, Winchendon provides a fairly sophisticated set of zoning bylaws integrating all of the provisions discussed above, including wetland protection, groundwater protection, and historic preservation overlay districts, site plan approval requirements for some developments, and phased development requirements. The bylaws also allow and encourage alternative development patterns through provisions for cluster developments and backlot development ("reduced frontage lots"), as well as incentives for downtown infill and redevelopment. Downtown development incentives include reduced minimum lot sizes (although, at ½ acre, the requirement is still high for downtown areas), potential for mixed uses, shared parking, apartment buildings, and accessory apartments.

A minor problem—and one that could be easily remedied—is that the requirement for site plan approval is triggered by the use, rather than the size of a proposed project, so that some very large developments may avoid this important level of review.

Franklin County

Erving

Review of Zoning Regulations that incorporate the reduction of NPSP (Zoning By-law – 2000)

The Town of Erving does not allow any land within the town to be used for the collection, treatment, storage, burial, incineration or disposal of hazardous waste including radioactive wastes and low-level radioactive wastes. Limiting the use and storage or disposal of hazardous substances assists with the prevention of a possible release of these substances into groundwater or other natural resources.

The Town of Erving Select Board or their appointed Building Inspector enforces erosion control during development or redevelopment of a site. The site design and materials and construction processes shall be designed to avoid erosion damage, sedimentation or uncontrolled surface runoff. Grading or construction on slopes of 25% or greater shall be allowed under Special Permit provided the applicant meets all necessary requirements through filing an erosion and sedimentation plan.

The minimum dimension requirements for lot sizes that have municipal water and sewer services is 20,000 square feet plus 7,000 square feet per unit in excess of one unit. The minimum lot frontage shall be 115 feet measured along a public way. Minimum lot requirements that do not have municipal water and sewer services are 30,000 square feet plus 10,000 square feet for each additional dwelling. This lot size could be considered small for both a private well and septic system.

Subdivision Regulations (1986)

A subdivision of land into two or more lots so as to create one or more lots which do not have the required minimum lot size are subject to file a Definitive Plan detailing potential changes to stormwater, soil erosion, loss of vegetative cover and/or other disturbances to the natural ecology of the site. Moreover, all land subdivisions must have an erosion and sedimentation control plan delineating drainage areas and outlining landscape design to minimize soil loss post construction. Approval of the final plan requires adequate preservation of

natural features, historical assets, community property and may require provisions for parks, open space and recreation areas.

Montague

Review of Zoning Regulations that incorporate the reduction of NPSP (Zoning By-law – 2000)

The Town of Montague has a Water Supply Protection District (WSPD) to protect the public health, safety and welfare by preventing contamination of the surface and ground water resources providing present and significant potential public water supplies to residents. Several types of non agricultural businesses and industries that process, store or dispose of hazardous materials or wastes as a principal activity or in amounts exceeding the minimum threshold amount requiring compliance with the MA DEP 310 CMR 30 are prohibited in the WSPD. Examples of these types of businesses would include dry cleaning, metal plating, wood preservation, furniture stripping, outdoor storage of salt, de-icing materials, pesticides or herbicides and motor vehicle service centers or fueling stations. However, commercial and self-service laundries are allowed in the WSPD provided they have a direct connection to a municipal sewer line.

Excavation of earth materials is allowed in the WSPD provided that at least six feet of material remains above the mean high water table elevation. However, this restriction does not apply to excavations incidental to the permitted uses, including but not limited to providing for the installation or maintenance of structural foundation, freshwater ponds, utility conduits or on-site sewage disposal.

Building Lots within the WSPD that are not served by municipal sewerage systems requires a minimum size of 45,000 square feet for single family homes and 67,500 square feet for two family homes. In certain portions of the WSPD some lot sizes are required to have a larger dimension and an Environmental Impact and Site Plan Review may be required before any development occurs in the WSPD or within Town boundaries. Lot sizes outside the WSPD and require a minimum of 22,500 square feet for single-family homes, two family dwelling is 45,000 square feet or multi-family home requires 45,000 square feet and 22,500 square feet per dwelling unit. Exceptions to the above requirements may be allowed under Special Permit where public water and sewer services are allowed.

All land uses that involve the construction or alteration of over 5,000 square feet of floor area or the development of over 130,680 square feet of land is required to file an Environmental Impact and Site Plan Review with the Zoning Board of Appeals. Land uses that are exempt in this by-law include agriculture, forestry or religious, educational and governmental services.

Subdivision Regulations (1989)

Under these regulations for the Town of Montague a subdivision of any land or lots may not proceed until a Definitive Plan has been submitted for approval to the Planning Board. Within in this plan the location of natural objects and surfaces such as waterways, natural drainage courses, ledge outcroppings, stone walls, and the location and species of all trees in excess of eight inches in diameter within the required front yard of each lot. The plan must also include all proposed storm drainage, water supply and sewage disposal system including all profiles and layouts of all utilities and appurtenant structures. In addition, a Registered Civil Engineer must certify the location of the sewage disposal facility.

An erosion control plan, including the locations of temporary stockpiles, spoil areas, temporary drainage areas, sediment basins and description of technique used to control erosion and sediment from entering existing streets, storm drain conveyances or other appurtenant structures located along abutting properties.

For a proposed subdivision of five or more lots an Environmental Impact Statement is required to ensure that the environmental health of the community and natural resources do not undergo any adverse environmental effects as a result of the proposed subdivision.

The subdivision regulations indirectly assist with the reduction of potential non point sources of pollution. These regulations include due regard for the protection of natural features such as large trees, water courses,

scenic points, historic locations and other community assets and may require provisions for open space for recreation or other conservation measures.

Northfield

Review of Zoning Regulations that incorporate the reduction of NPSP (Zoning By-law – 1999)

The Town of Northfield has a Floodplain District and a Water Supply District and provides basic protective measures for water resources. The Water Supply District provides protection to groundwater resources by limiting land uses that are common potential sources of non point source pollution (e.g., trucking and bus terminals, underground storage tanks and commercial mining of land). Earth removal is limited in the Water Supply District but may be allowed under special permit. The Water Supply District is located in the Connecticut River Watershed.

The Zoning bylaw incorporates erosion and sedimentation controls to any land development or redevelopment of a site, including grading regardless of whether special permits are required. Moreover, no construction or grading shall result in a change in the natural surface drainage onto abutting properties.

Site Plan Review is required for replacement of all underground fuel storage systems, businesses and industrial use other than agriculture, uses that generate sewage flow that exceed 1,500 gallons per day or septic systems within a horizontal distance of 100 feet from the centerline of every stream. This includes both perennial and intermittent streams. In addition, construction of any building or structure intended for human residence within 100-feet of a stream requires site plan review. Grading and construction on slopes in excess of 25% must have adequate stormwater and erosion controls in place to reduce potential environmental degradation.

Minimum lot sizes for the Residential and Agriculture District are 1.25 acres. Lots in the Residential/ Agricultural and Forest District must have minimum of 2.5 acres. These lot sizes assist with providing adequate buffers for septic systems and private water supplies. However, building lots can be 0.75 acres provided the property is connected to the municipal sewer system. The WWTF is located in the Connecticut River Watershed.

Subdivision Regulations (1992)

A subdivision of land into two or more lots so as to create one or more lots which do not have the required minimum lot size are subject to file a Definitive Plan detailing potential changes to stormwater, soil erosion, loss of vegetative cover and/or other disturbances to the natural ecology of the site. Moreover, all land subdivisions must have an erosion and sedimentation control plan delineating drainage areas and outlining landscape design to minimize soil loss post construction. Approval of the plan requires adequate preservation of natural features, community assets and, where applicable, provisions for open space and recreation areas.

Orange

Review of Zoning Regulations that incorporate the reduction of NPSP (Zoning By-law – 1999)

Site Plan approval is required for any use not specifically permitted by right. This generally includes large-scale residential and commercial development. In addition, special permits are required for storage of hazardous materials and in any case where adequate safeguards have not been taken to protect the natural resources.

The Town of Orange has a Water Resource District that assists with the protection of public and environmental health by restricting nonconforming uses upgradient of the ground and surface water resources that provide water supply for most residents. This district has several listed land use controls that minimize potential non point source pollution threats to the water supply. These include no: generation, treatment or disposal of hazardous substances except where special permits may be issued to very small quantity generators or water remediation treatment plants; landfills; outside storage of salt or deicing products; junk yards; truck terminals with a capacity to park ten or more trucks; automotive service stations that are not connected to Town Sewer; stockpiling or disposal of snow containing spent deicing chemicals; and, special waste and septage landfills. In addition, removal of earth materials within four feet of the historical high groundwater table elevation is not permitted

unless through a special permit for earthen materials that will be redeposited within 45 days of removal to achieve grading greater than four feet above historical high groundwater elevation or building foundations and utility work. Land use that results with impervious surfaces covering more than 15% or 2500 square feet of any lot requires a special permit within the Water Resource District.

The Town Building Inspector enforces erosion control during development or redevelopment of a site. The site design and materials and construction processes shall be designed to avoid erosion damage, sedimentation or uncontrolled surface runoff. Grading or construction on, or which result in slopes of 25% or greater on 50% or more of lot area, or on 43,560 square feet or more on a single parcel shall be allowed under Special Permit provided the applicant meets all necessary requirements.

The Town of Orange has a 100-year floodplain overlay district that provides basic flood protection to the town above the requirements of the M.G.L. c. 131 s. 40 (Wetlands Protection Act) and M.G.L. c. 258, Acts of 1996 (Rivers Protection Act). The overlay district allows uses with low flood damage potential or no net increase in flood potential and requires a special permit for all other uses.

The Town of Orange has an Open Space Development provision that encourages the permanent preservation of common land for conservation, agriculture, open space, forestry, wildlife habitat and recreational use; protection of water supply sources and natural landscaped features. The minimum lot size for the Open Space Development is six acres. This type of zoning standard indirectly assists with the protection of recharge areas to ensure water quantity and stormwater infiltration, which reduces potential flood impacts.

Subdivision Regulations (July 1988)

Under these regulations for the Town of Orange a subdivision of any land or lots may not proceed until a Definitive Plan has been submitted for approval to the Planning Board. The plan must document the location of natural objects and surfaces such as waterways, natural drainage courses, ledge outcroppings, stone walls, and the location and species of all trees in excess of eight inches in diameter within the required front yard of each lot. The plan must also include all proposed storm drainage, water supply and sewage disposal system including all pro-files and layouts of all utilities and appurtenant structures.

The subdivision regulations indirectly assist with the reduction of potential non point sources of pollution. These regulations include due regard for the protection of natural features such as large trees, water courses, scenic points, historic locations and other community assets and may require provisions for open space for recreation or other conservation measures.

Warwick

Review of Zoning Regulations that incorporate the reduction of NPSP (Zoning By-law – 1995)

The Town of Warwick has incorporated several general provisions that assist with reducing potential non point sources of pollution. The prohibited land use in the Town of Warwick include commercial sale of used motor vehicles; junk yards and motor vehicle junk yards; accumulation of motor vehicles on site unless screened from all public ways; outdoor collection or storage in commercial quantities of salt, de-icing materials, pesticides or herbicides; commercial wood preserving and furniture dip stripping operations; storage, collection, treatment, burial or incineration of hazardous materials including radioactive materials. These provisions seek to prevent contamination of surface and ground water supplies.

Warwick has made additional provisions for building density and dimensional regulations. Due to the types of soil, site drainage for water and topographical conditions only one principal building shall be located on any lot. Each lot for a principal building containing one dwelling or two attached dwelling units must have a minimum of two acres and 300 feet of frontage along an existing public way or approved subdivision road. These regulations allow for adequate buffer areas between water recharge areas for private wells and septic systems.

The Town of Warwick has also incorporated a Conservation Development article that encourages the preservation of common land for conservation, agriculture, open space, forestry and recreational use; to preserve histori-

cal or archaeological resources; to protect existing or potential public or private water supplies, protect the value of real property; to promote more sensitive sitting of buildings and better overall site planning; to promote better utilization of land in harmony with its natural features and with the general intent of the zoning bylaws through a greater flexibility in design; and to protect wildlife habitat.

Warwick has an Erosion Control ordinance enforced by the Town Building Inspector to mitigate soil instability, uncontrolled surface water runoff, environmental degradation and other permanent or temporary damage caused by conditions which may exist either during or after site development or redevelopment occurs. Earth removal is allowed provided the scope is limited to the construction of a building, grading of contiguous property or allowed under Special Permit. Further the town does not allow construction or alteration of surface features or contours to take place on slopes in excess of 25% unless a Special Permit is obtained through the Zoning Board of Appeals.

Subdivision (1987)

Any subdivision shall mean the division of a tract of land into two or more lots and shall include re-subdivision, and, when appropriate to the context, shall relate to the process of subdivision or the land or territory subdivided. An impact statement must accompany a subdivision plan detailing probable effects of changes in surface drainage; land erosion or loss of vegetative cover; and disturbance to other aspects of the natural ecology.

Design standards regulations include due regard for protection of natural features such as large trees, water courses, scenic points, historic spots and other community assets and may require provision of open space and recreation or other purposes. The Required Improvements section calls for stormwater drainage systems to be designed for a "fifty year" storm under conditions of total potential development permitted by the Zoning bylaw and the effect of each subdivision on the downgradient facilities outside of the proposed subdivision. To further reduce potential erosion during subdivision all banks that have a tendency to erode (i.e., slopes greater than 3:1) must be planted with species that create dense root systems and acceptable to the Planning Board. Other erosion control measures require mulch or wood chips on all exposed soil to reduce potential wind blown or wash out of soil areas.

The depth to the average water table must also be shown on all plans. This assists with a soil buffer for water quality protection from potential contamination due to releases or leachate of petroleum oil or other hazardous substances near the upper groundwater elevations.

Wendell

Review of Zoning Regulations that incorporate the reduction of NPSP (Zoning By-law – 1995)

The Town of Wendell has incorporated several zoning regulations that may assist with the reduction of potential non point sources of pollution. The Special Permit Criteria requires that all efforts must be made to minimize the displacement of stonewalls, trees, natural and historical land features and buildings, soil and vegetation, and wildlife and aquatic habitat. Consideration of stormwater drainage systems to minimize erosion and protect against silt build-up, must be provided during development or redevelopment of a potential building lot. The use regulations prohibit numerous industrial land uses that would handle hazardous chemicals and wastes.

Prohibited Industrial Land Use in the Town of Wendell

- Acetylene, cyanide or oxygen manufacture;
- Asphalt manufacture;
- Chlorine or Bleaching Manufacture;
- Creosote;
- Distillation of Coal;
- Foundry;
- Explosives;
- Fertilizer;

- Fumigation plants;
- Glue or size manufacture from fish or animal offal;
- Gypsum, cement, or plaster production;
- Incineration, reduction or dumping of offal; (Except where controlled by the Town of Wendell)
- Match Manufacturing
- Motor raceways and race tracks;
- Storage, collection, treatment, burial, incineration, or disposal of radioactive wastes, including but not limited to low level radioactive wastes;
- Commercial uses that manufacture, process, store and dispose of hazardous waste in amounts exceeding those permitted for very small waste generators;
- Trucking or busing terminals;
- Solid waste landfills, dumps, (Except where controlled by the Town of Wendell);
- Underground storage and or transmission of oil, gasoline, or other petroleum products, excluding liquefied petroleum gases;
- Outdoor storage of salt, de-icing materials, pesticides, or herbicides (Except where controlled by the Town of Wendell); and,
- The rendering impervious by any means of more than 10% of the area of any single lot or more than 13,000 sq. ft. which ever is the lesser amount.

The Town of Wendell has also incorporated a Conservation Development article that encourages the preservation of common land for conservation, agriculture, open space, forestry and recreational use; to preserve historical or archaeological resources; to protect existing or potential public or private water supplies, protect the value of real property; to promote more sensitive sitting of buildings and better overall site planning; to promote better utilization of land in harmony with its natural features and with the general intent of the zoning bylaws through a greater flexibility in design; and to protect wildlife habitat.

Wendell has made additional provisions for building density and dimensional regulations. Due to the types of soil, site drainage for water and topographical conditions only one principal building shall be located on any lot. Each lot for a principal building containing one dwelling or two attached dwelling units must have a minimum of three acres and 200 feet of frontage along an existing public way or approved subdivision road. These regulations allow for adequate buffer areas between water recharge areas for private wells and septic systems. The Town of Wendell has incorporated these regulations to promote the health, safety and welfare of the inhabitants in accordance with the Zoning Act, Chapter 40A, Massachusetts General Laws to promote and maintain agricultural and other natural resource-based activities and water quality and quantity and to preserve the ecology and rural nature of the town.

Subdivision (1989)

The Town of Wendell has very similar Subdivision Regulations as the Town of Warwick. Described further, any subdivision shall mean the division of a tract of land into two or more lots and shall include re-subdivision, and, when appropriate to the context, shall relate to the process of subdivision or the land or territory subdivided. An impact statement must accompany a subdivision plan detailing probable effects of changes in surface drainage; land erosion or loss of vegetative cover; and disturbance to other aspects of the natural ecology.

Design standards regulations include due regard for protection of natural features such as large trees, water courses, scenic points, historic spots and other community assets and may require provision of open space and recreation or other purposes. The Required Improvements section calls for stormwater drainage systems to be designed for a “fifty year” storm under conditions of total potential development permitted by the Zoning bylaw and the effect of each subdivision on the downgradient facilities outside of the proposed subdivision. To further reduce potential erosion during subdivision all banks that have a tendency to erode (i.e., slopes greater than 3:1) must be planted with species that create dense root systems and acceptable to the Planning Board. Other erosion control measures require mulch or wood chips on all exposed soil to reduce potential wind blown or wash out areas.

The depth to the average water table must also be shown on all plans. This assists with a soil buffer for water quality protection from potential contamination due to releases or leachate of petroleum oil or other hazardous substances near the upper groundwater elevations.

C. Zoning Compatibility on Town Boundaries

Regional planning provides the opportunity to evaluate whether land use patterns and regulations are consistent and compatible across town boundaries. When neighboring communities fail to coordinate their planning objectives and policies, these communities may suffer the consequences of incompatible land uses (such as residential uses adjacent to industrial uses), resources that are inadequately protected, and missed opportunities for effective inter-municipal planning. The Greater Gardner Sustainable Growth Management planning team identified several potential areas for improvement in inter-municipal coordination.

1. Zoning Districts

Since the watershed is predominantly zoned for low-density residential uses, there are few incidents of markedly different zoning districts across municipal boundaries. Those that do exist may not necessarily be problematic, but should at least be noted, as they would seem to imply divergences of opinion as to the envisioned future uses of these bordering areas.

1. Winchendon/Ashburnham: The town of Winchendon has zoned a relatively large area along its eastern border with Ashburnham as Industrial. The corresponding area on the Ashburnham side of the border is zoned for residential use and includes areas protected by its Watershed Protection Overlay District. Under §3 of the Winchendon Zoning Bylaw, the Industrial zone allows a number of industrial uses (warehouse, manufacturing, storage or salvage yard), some as-of-right, that are prohibited across the border.

2. Gardner/Westminster: The City of Gardner has designated two "Industrial II" zones in the eastern section of the City, one along Route 2 and the other along Route 140. In Westminster, in the areas adjacent to Gardner's Industrial II zones, there is a small Commercial district surrounded by R-I and R-II zones. Although the industrial zoning may be appropriate along these major routes in Gardner, corresponding residential growth in Westminster could lead to land use conflicts across the municipal boundary.

3. Phillipston/Athol: Phillipston as zoned the entire area along Route 2 into a Commercial/Industrial Zone. The zone surrounds a Recreation Zone that protects three reservoirs, and it borders Rural Residential Zoning in Athol. It also encroaches on Thousand Acre Swamp. These areas have been identified as Outstanding Resource Waters. Several uses permitted in the Commercial Industrial Zone are prohibited in both the Recreation Zone and the Rural Residential zone.

4. Templeton/Winchendon/Gardner/Hubbardston/Phillipston: Templeton has no zoning in the sense used by its neighbors. There are no use zones, and there are no prohibitions of land uses, nor limitations of use intensity. As such, potential exists on every border for uses that are incompatible with the uses across the border.

2. Residential Lot Size Requirements

Although most lands along the municipal boundaries in the nine towns have been zoned for residential use, there are a number of discrepancies when one compares required lot sizes in abutting areas across the borders. Most notable are the following:

1. Winchendon/Templeton: Winchendon's two-acre minimum-lot-size zone abuts Templeton's one-acre zone. This is more likely to be of concern on Templeton's northeastern border than on its northern border. The Army Corps of Engineers Birch Hill Dam Flood Control Project prohibits development in Winchendon. Proximity to this project may make development in Templeton sensitive to flooding, and the Town may want to consider design restrictions for this region to minimize flood risk.

2. Hubbardston Templeton: Hubbardston also has a two-acre minimum zone on its border with Templeton. Growth in Templeton has taken place in the southeastern quadrant of the town, in the vi-

cinity of Route 2. Proximity to the highway and the commercial and industrial areas of Garder make this region attractive for development.

3. Winchendon/Ashburnham: In some locations along this boundary, Winchendon's 87,120 s.f. minimum lot-size zone abuts Ashburnham's 60,000 s.f. zone.

4. Depending on whether they are served by municipal water and sewer services, certain areas in Gardner may also allow development on significantly smaller lots than abutting areas in neighboring towns.

Although these discrepancies may seem minor, a tract of land in one town could accommodate twice as many homes as an identical abutting tract in another town. These differences could result in high rates of growth on one side of a municipal boundary and much lower rates on the other side of the boundary, even though both areas might have similar physical characteristics.

3. Water Resources Protection Districts

Most of the Millers River municipalities have designated water supply protection districts in which certain uses are regulated, in order to protect municipal water supplies. Most of these protection districts are similar in nature as to the sort of uses allowed or prohibited. However, since natural aquifer recharge areas do not necessarily follow municipal boundaries, land use decisions in one town may adversely affect the water supply of a neighboring town where districts do not match up, or are absent altogether (as is the case of Templeton, and Phillipston). Water supply protection districts should always correspond to natural recharge areas, regardless of municipal boundaries, and should be present in every community, whether or not it relies on public wells for some or all of its drinking water. To accomplish this region-wide groundwater protection program, some inter-municipal cooperation may be required.

VII. Recommendations

A. Recommendations for Existing Land Uses

1. Assess Management and Operational Practices of High Risk Land Uses

Research of relevant town documents, informal interviews and a windshield survey of the Millers River Watershed were conducted to develop a comprehensive inventory of existing and potential sources of non-point source pollution in the watershed. Specific, actual management and operational practices of potentially non-sustainable land uses in the watershed should be updated annually. Inspections and analyses should be conducted on medium to high-risk land uses and management practices in each community, and best management practices (BMPs) implemented. Potential entities which might conduct such inspections and analysis include the Millers River Watershed Team or the Department of Environmental Management. Alternatively, individual communities may assign these responsibilities to the Board of Health or the Health Inspector.

a) Road-Salt Storage and Application

Salt runoff comes from highway department storage and certain snow removal practices, including the disposal of salt-laden snow, which, historically contributed to contamination of drinking water supplies throughout the Commonwealth. Further, accumulation of salt in streams can damage aquatic ecosystems and affect human health since streams can act as recharge areas for groundwater drinking supplies. To reduce associated risks of outdoor storage of salt, legislation was enacted:

Pursuant to M.G.L. Chapter 85 Section 7A the storage of deicing materials within a groundwater supply or two hundred feet of a water resource is prohibited unless confined to a solid framed shed to ensure against groundwater leaching. Further, this regulation may determine the place where such chemicals are applied. This regulation applies to all highway garages or persons who use more than 1 ton of deicing chemicals within a twelve-month period. These persons must also report their usage/amounts per road section of deicing chemicals to the MA DEP.

Recommendations: Although some consider road salting a low priority water resource threat,[58] the need for salt or deicing materials should be assessed within water supply recharge areas. The DPW directors of the towns and MassHighway should assess the need for salt or other deicing material within the watershed to reduce, eliminate, or find alternatives to road salt use in recharge areas. Tables IV-13 and IV-14 on Pages IV-16 and 17 list the community water supplies for which there are no protection plans. We recommend that a Salt Policy be enacted within the Millers River Watershed. Specific attention should be given to deicing procedures and storage practices used at airports, as well.

To limit salt damage:

1. Reduce salt use by establishing “low salt areas” in sensitive environments or residential areas, or by using a higher percentage of sand in the sand/salt mix.
2. Time salt applications appropriately (?)
3. Wet salt before applications so that it sticks to the road more easily.
4. Don’t dispose of salt-laden snow in salt-marsh or vegetated wetlands, rivers, shellfish beds, mudflats, drinking water sources, or ACEC’s.
5. If must dispose of salt-laden snow in waterways, the water should have adequate flow to provide mixing.
6. Snow fences and trees can be used to keep snow from blowing onto the road.
7. Store salt in a covered building on an impervious surface. Drainage should be designed to divert runoff away from the structure and to collect any contaminated material. These facilities should be constructed so that all handling of material is done in an enclosed area and should not be located in water supply watersheds.

[58] Rizzo Associates, 1991

To limit sand damage:
1. Sweep streets at least twice a year (spring and fall).
2. Clear catch basins of sand and debris.

b) Highway and Urban Runoff

Highway and related non-point source pollution urban runoff should be assessed for all highways and public ways within the wellhead protection zones as well as those within the 200-foot Rivers buffer zone.

Recommendations: Where needed, additional structural and non-structural Best Management Practices (BMP's)[59] such as vegetated buffer strips should be applied to correct runoff problems. Problem areas may be identified with the assistance of a well-organized water monitoring program. Local communities can use The Highway Functional Classification System [60] to determine how all of the towns' roads are classified and more specifically, which ones are generally used for the transportation of hazardous materials. Towns can obtain the Functional Classification from MassHighway. In addition, the MassHighway should modify the Annual Road Inventory File to stratify its classification of roads by Functional Classification, Jurisdiction, and pavement condition (paved and unpaved). At present such an in depth classification is unavailable and requires a significant amount of work to develop.

c) Urbanization

Urbanization is the biggest threat to water quality and quantity. As noted, the impacts of urbanization include the increases of impervious surfaces and stormwater runoff, non point source pollution, loss of open space, river connectivity, riparian buffers, public recreation access and other negative environmental impacts.

Recommendations: Encourage smart growth, which is an alternative to sprawl that promotes compact growth in and around existing urban centers, along with preservation of open space and environmental quality. Institute site design practices that minimize environmental impacts, such as cluster development, open space subdivision design, and use of brick or crushed stone on paths or walkways to allow for pervious surfaces in low traffic areas. Planning Boards of each community should make use of the Buildout Analyses to address zoning amendments and changes. The Planning Board and the Zoning Board of Appeals should use Site Plan Review and Site Design Standards with an aim toward limiting creation of impervious surfaces, preventing poor stormwater management practices, and limiting development of new roads. Communities should amend their parking design regulations to shift the focus from minimum dimension to maximum dimensions and relate development of parking lots to an overall ratio of impervious surfaces in the community.

d) Stormwater Management

Assessments of site-specific stormwater problems and their overall hydrogeologic connection with Millers River should be completed. At present, the Millers River Team has a contract with an engineering firm to conduct a hydrological study of the watershed. Some stormwater problems can be addressed with town bylaws dealing with erosion. Also competitive bioengineering grants (e.g., Sec 319 of the Clean Water Act), vegetated buffer strips and other non-structural best management practices are available to address riverbank erosion and runoff areas within the watershed.

Recommendations: Additional stormwater control measures, including vegetated buffer strips, should be developed and implemented within the watershed. The local Department of Public Works and the MassHighway can make use of the extensive information on bridge scour and streambank erosion in the USGS/MassHighway Scour Assessment database referenced in this document on pages IV-30-32. The Adopt-a-Stream program may want to sponsor new Stream Teams for the Millers River Main Stem, to cover segments from the headwaters of both of its branches to the confluence with Otter River, and from there through Erving.

[59] Pioneer Valley Planning Commission and Franklin County Commission, 1994
[60] U.S. Department of Transportation, 1989

e) Agricultural Land

All agricultural land in the watershed should be assessed in regards to the pesticides and fertilizers used and to the timing and rates of application. Higher priority should be given to those agricultural lands that are within the Recharge Areas (Zone II). The Natural Resources Conservation service or the Franklin Conservation District would be the best organizations to conduct assessments.

Recommendations: The towns should request assistance from the Natural Resources Conservation Service, Franklin Conservation Districts, to provide outreach training for farmers and other users of agricultural lands to encourage the use of agricultural or Forestry BMPs.

To minimize livestock impact:
1. Fence cows out of streams.
2. Store manure on impervious (cement) surface.

f) Pesticides

Pesticides used to control weeds, insects and plant diseases have the potential to contaminate groundwater which is used as a drinking water source. Improper disposal, accidental spills, excessive or inappropriate use, misapplication, overuse and poor storage practices are all ways in which pesticides can contaminate groundwater supplies. Proper use of pesticides is an important step toward preventing groundwater contamination.[61]

Recommendations*:* The Farm Bureau, the US Department of Agriculture, the Natural Resource Conservation Service, and local Boards of Health and Conservation Commissions can work together to encourage reductions in pesticide use through dissemination of flyers and handouts that emphasize non-chemical control methods, such as removal of pest habitats by cleaning up solid waste, junk cars that hold standing water, leaf piles, and other loose household garbage.

g) Solid Waste Management

Solid waste management facilities have long been sited nearest the land perceived to have the least value in a community. Traditionally, these areas were located on hillsides above rivers, streams and wetlands. The content of refuse in landfills has become increasingly complex and toxic in the past 100 years. Definitions of the value of land are changing as we begin to recognize the value of wetlands, rivers, streams, lakes, and ponds to the health of the environment and the quality of our drinking water supplies. To this end, communities must recognize the importance of environmentally sensitive disposition of refuse.

Recommendations*:* To limit mercury and cadmium inputs through battery disposal, recycle nickel cadmium (nicad) rechargeable batteries, all batteries that contain mercuric oxide and "button" batteries commonly used in calculators, cameras, hearing aids and watches. Most alkaline batteries have a low mercury content and are safe to throw away. Battery recycling centers should be established at land fills and transfer stations. Regionally, watershed communities may need to look at their solid waste management and landfill siting practices to devise a more environmentally sensitive strategy. Existing regional solid waste management plans should be updated. If none exit, a new one should be developed

2. Work with Landowners to Voluntarily Implement Best Management Practices

The towns should try to work cooperatively with residential, agricultural, forestry, commercial, and industrial landowners to conduct a voluntary assessment of management and operational practices.

This recommendation should be partnered with educational outreach to help landowners understand the effects their living and business practices may have on the quality of the surface and groundwater in their community. Workshops, volunteer water monitoring programs, and a press release series could help to popularize the notion of being pro-watershed.

[61] MA DEP Fact Sheet for Pesticides

3. Adopt Board of Health Regulations to allow Inspection of Potentially Hazardous Land Uses

If there is a situation where landowners are not willing to participate in a voluntarily self-assessment program, the Board of Health in each town should adopt regulations which allow inspection of high-risk land uses in the watershed. This could include requiring recharge areas of the well head protection zones as well as those uses that are within the 200 feet riverfront buffer area identified in the Rivers Protection Act, including those uses exempt from the Act such as agriculture and forestry.

4. Adopt Regulations to Correct Management Practices Which Degrade Water Quality

Following a land use inspection process, those practices believed to be hazardous to water quality should be required to be corrected through Board of Health Regulations, enforcement of existing laws, or through the use of new zoning bylaws. Active and closed landfills located adjacent to or above water resources should be carefully monitored. Communities and monitoring authorities should anticipate potential threats to water resources becoming actual impairments and should publicize mitigation plans for cleanup.

5. Identify the Locations of On-Site Septic Systems

The towns should identify the location of on-site septic systems located within the watershed area especially those within 200 feet from any lake, pond, or stream. These systems should be inspected bi-annually to ensure that excess nutrients are being removed from the leachate. This may assist with preventing nuisance plant growth in surface waters. Towns can apply for Community Development Block Grants to repair and replace failing septic systems in low and moderate income households. Additional funding may be available through the Massachusetts Division of Water Pollution Control Septic Management Programs, or through programs sponsored by the Department of Environmental Management.

6. Identify the Location of Underground Storage Tanks (USTs)

The location and condition of underground storage tanks should be inspected annually to ensure compliance with current Federal and State Regulations. Each town should make sure that all tanks have been replaced since the 1998 rule. There should be concerted effort to identify any abandoned USTs. The towns should not permit underground tanks for industrial or agricultural uses in water supply recharge areas, regardless of containment system.

7. Monitor Clean-up of Hazardous Waste Site(s)

The Towns and Conservation Commissions should monitor all small releases of these spills to ensure that no potential threat exists from oil or hazardous material leaching into the groundwater supply. The responsible party should be required to at least inform Conservation Commissions that a release had occurred and was cleaned up following all necessary regulations and that no threat to drinking water supplies exist.

8. Testing for Pesticides in Municipal Wells

Agriculture is an important activity in the Millers River watershed. The 1992 Massachusetts Department of Agriculture regulations require pesticide applicators to declare if they apply pesticides in a restricted Zone II area. A list of pesticide users, types and quantities should be submitted to the local boards and fire departments in the event of a release to the environment. There is also a need to inform landowners of the Zone II areas and of the regulations that apply.

B. Recommendations for Regulations on Present and Future Land Uses

The analysis of zoning contained in this document is a first step toward addressing the relationship of zoning to the overall quality of the environment, the quality of our water resources, and the management of land uses that may have a harmful impact. The watershed would certainly benefit from a more comprehensive comparison of zoning practices in each of its communities, to evaluate the effectiveness of the language each community has adopted. The Regional Planning Commissions are available to conduct such a comprehensive analysis.

1. Water Supply Protection Overlay Bylaw

Adopt a Water Supply Protection Zoning Overlay Bylaw
The towns that do not have a water supply protection zoning overlay district to protect the primary and secondary recharge areas should consider implementing.

Changes to the Existing Bylaw
If the towns do not adopt the comprehensive water supply overlay protection district then perhaps they should consider making the following changes to their existing zoning bylaw:

- Include a definition of Hazardous Materials in the Zoning Bylaw;
- Remove uses in the aquifer recharge areas that generate, treat, process, store or dispose of hazardous wastes from uses allowed by special permit. The town can apply an overlay district if it does not want to prohibit them town-wide;
- Prohibit the land filling and/or storage of sludge or septic waste;
- Prohibit auto recycling;
- Remove certain hazardous land uses in the aquifer recharge area such as wood preserving, furniture stripping and refinishing, and trucking and busing terminals from uses allowed by special permit.
- Specifically prohibit metal plating, chemical manufacturing, auto recycling, and auto body repair. The town can apply an aquifer recharge overlay district if it does not wish to prohibit them town-wide.
- Do not allow auto service, sales, and repair by special permit in the commercial and industrial zones, for those parts of the districts that are within the aquifer recharge areas;
- Include a prohibition of individual sewage disposal systems designed to receive more than 110 gallons of sewage per quarter acre per day under one ownership in the recharge areas;
- Include a prohibition of stockpiling and disposal of snow in the primary and secondary recharge areas that contain sodium chloride, calcium chloride, or other chemicals or treated abrasives used in snow and ice removal;
- Include a prohibition of outdoor uncovered storage of animal manure;
- Require a hazardous materials management plan as a condition of a special permit for those permitted uses storing hazardous materials; and,
- Include a review of special permit and site plan review applications by other town boards, such as Planning Board, Board of Health, Conservation Commissions, Fire Chief. This should occur at least in the recharge areas for all water supply systems.

2. Hazardous Materials Bylaw

The towns lacking a hazardous material bylaw should consider adopting one that contains the following provisions: prohibit the storage or use of hazardous materials within the recharge areas; also prohibit the use of toxic cleansing chemicals in residential septic systems.

The Hazardous Materials Bylaw should require all businesses using and storing hazardous materials to file a hazardous waste management plan detailing provisions to protect against the discharge of hazardous materials and wastes, provisions for secured, indoor storage of hazardous materials, and evidence of compliance with state laws with the local board of health.

3. Underground Storage Tank Bylaw

The towns that lack an Underground Storage Tank (UST) Bylaw should consider adopting one. This could include a requirement that landowners report the locations and conditions of all underground storage tanks to the Boards of Health (note: currently, a landowner only needs to notify the local fire chief). The use of UST's for agricultural use within recharge areas or within the riverfront area should be prohibited.

4. Earth Removal Bylaw

Sand and gravel in the unsaturated zone provides a "natural filter" that protects the recharge areas by greater attenuation. The thicker the natural filter in the unsaturated zone, the greater the purifying effect and the slower contaminants percolate downward. Mining of sands and gravel removes this protection. Therefore no quarrying activities within the critical recharge areas of public or private water supplies should be allowed.

The towns should consider requiring through their Earth Removal Bylaws that all excavation or disturbance of any soils, no matter the use, adhere to Best Management Practices. Excavation should not be permitted within the aquifer recharge areas regardless of height above mean annual groundwater elevation. Existing sand and gravel excavation sites should be inspected to ascertain their potential impact, with future use, on the health of both surface and groundwater.

5. Impervious Cover Bylaw

The towns should adopt an impervious surface Zoning bylaw. Specifically, pursuant to the Massachusetts Wellhead Protection Regulation 310 CMR 22.21(2)(b)(7) municipalities with an MADEP approved Zone II for a public well requires the adoption of this bylaw. Generally, this bylaw states that "land uses that result in the rendering impervious of more than 15% or 2,500 square feet of any lot, whichever is greater, unless a system for artificial recharge of precipitation is provided that will not result in degradation of groundwater quality." Since there are several public well systems throughout the watershed we recommend that the towns adopt an impervious surface Zoning bylaw to ensure high quality recharge to the aquifer. Such a bylaw can also be written to limit the amount of land near the rivers that is rendered impervious.

6. Environmental Impact Analysis

Towns that do not have an environmental impact analysis should adopt this requirement in their zoning bylaws for large development projects in the entire town or specifically within the drinking water recharge areas. An environmental impact analysis would allow the planning board to control stormwater runoff through infiltration in the ground for recharge.

7. Private Wells

The towns within the watershed should adopt private well regulations. In addition to protecting private wells these regulations should establish drilling and capping standards for all wells, including monitoring wells for all industrial or commercial use.

8. Wetland Bylaws

The towns that lack wetland bylaws should consider adopting one to gain a higher standard of water resource protection. The bylaw should also support the protection of the riverfront resource areas from activities currently exempt from the Rivers Protection Act, such as agriculture and forestry, and require stricter erosion and sedimentation controls during installation of temporary stream crossings.

9. Protection of Watercourses in Recharge Areas

At a minimum Zoning regulations should be consistent with the River Protection Act and contain the following requirements: (1) no on-site subsurface sewage disposal systems should be allowed within 400 feet of surface reservoirs, within 200 feet from tributaries, and within 50 feet from other surface water supplies; and (2) no dwelling, parking area for more than five cars or an impervious surface area greater than 300 square feet constructed within 75 feet of the high water mark.

10. Septic System Regulations

Local Board of Health regulations should prohibit the use of toxic septic tank cleaners or additives, such as methylene chloride and 1-1-1 trichlorethane, which can severely contaminate groundwater supplies, especially in the highly permeable sand and gravel deposits. The towns may want to consider this at higher elevations in the watershed for greater protection of surface waters and recharge areas. Adopting a Board of Health Regulation that defines the inspection and testing of septic tanks to coincide with a standard schedule stated within the by-law might overcome problems with enforcement of this bylaw.

C. Conclusion

We identified issues and rendered suggestions important to the protection of the entire watershed. The following recommendations are based on their identification, assessment, and analysis of potential and existing sources of non-point pollution:

- Highway runoff capacity should be assessed for all highways in regional wellhead protection areas. BMPs should be implemented to correct highway run-off;
- Spill response plans should be assessed/established for all Communities;
- Site-specific stormwater management assessments should be conducted for all land uses in the study area that have an impervious surface over 2,500 square feet;
- An inspection of all agricultural land in regional wellhead protection areas should be conducted inventorying crops grown, rates of pesticide application, types of pesticides applied, tillage practices, timing and amount of manure application, and number of animals grazing;
- The Boards of Health should adopt regulations to allow inspection of high-risk land uses in regional water supply protection areas. Practices believed to degrade water quality should be fixed through regulations or enforcement of existing laws;
- Boards of Health should adopt regulations prohibiting the use of toxic septic tank cleaners or additives;
- Purchase critical sections of the recharge area to insure protection; and,
- Gain public support for protection efforts and reduction of Non point sources of pollution.

In conclusion we recommend establishing no, or low, pesticide application areas in the recharge areas for all public drinking water supplies. BMPs should be employed for all infrastructure maintenance in wellhead protection areas. The application rates of road salt or other de-icing materials should be obtained for all roadways in the watershed. Formal road salt policy statements should be pursued within town highway departments and state officials for those roads in the wellhead protection areas. Policy statements should seek to limit road salt application rates or to seek alternatives.

Based upon the findings of our land use analysis, the following uses or activities were the most common moderate to high threats of potential non-point pollution sources: stormwater management, agriculture, hazardous material use, illegal dumping, possible non-sustainable forestry, and road salt use. Educational programs directed at different landowner groups can be developed with measurable evaluation tools in place, such as a reduction in lawn fertilizer rates or types of agricultural and forestry best management practices adopted.

While some communities have existing open space plans, they should be updated and combined to develop a regional open space plan. The regional open space plan would show that communities are connected by water and demonstrate the importance of sustainable land use in the watershed.

Reduction with non-point source pollution represents the missing link with watershed cleanup. It is the result of every one of our daily decisions: how we care for our lawns, how we wash our cars and what we use to paint our house. Therefore, the solution to non-point source pollution must incorporate citizens' behavior modification and requires a popular, grass roots approach. Standardized and clear "command and control" mechanisms such as bylaws and Board of Health regulations are also very important. These must not only be enforced by the appropriate officials but by peer pressure from concerned neighbors.

VIII. ***Action Plan***

A. From the Stream Teams

1. Otter River

Otter River has many scenic beautiful marshlands, though as it traverses Gardner and Templeton, it is susceptible to pollution from commercial, industrial and residential sources. Some land uses at points along the river are incompatible with river protection goals. Stream Team priorities are based on the segments delineated on the Otter River Stream Team Map on page V-6.

Departments of Public Works and Department of Environmental Management

- Initiate Clean-up Program to remove debris and house trash from the river and its banks, at the homeless/teenager encampment found on Segment 6, and around bridge abutments.
- Determine options for removing all or part of old dam to open the river up for recreational canoeing and kayaking.

Departments of Public Works and MassHighway

- Install a siltation fence at dirt road near sewer pumping station on Segment 2.
- Investigate Bridge Street construction to determine if implementing Best Management Practices (Segment 5).
- Mitigate erosion problem from Riverside Road found on Segment 5.
- Improve mitigation measures and reduce noise at functioning gravel operation.
- Secure abandoned gravel operations to control sedimentation affecting the river.
- Design improvements to stormwater management at parking lot
- Rebuild bridge, mitigate road sediments washing into river

Boards of Health and Department of Environmental Protection

- Investigate potential hotspots, including paper mill area and pipe effluents found in Segments 2, 7.
- Encourage DEP and EPA to investigate possible PCB contamination from Templeton Wastewater Plant. If found to be true, encourage DEP and EPA to enforce cleanup.
- Monitor and mitigate contamination from the Gardner landfill.
- Monitor dumping areas found on Segment 6 for leachate.
- Determine if dumping areas found on Segment 6 are legal. If not, investigate options for eliminating the sites and cleaning them up.
- Discourage dumping near the Gardner Municipal Airport by aggressive patrolling.

Conservation Commissions

- Find options for protecting undeveloped land.
- Develop plan and apply for grant for historic/nature trail along river, including rebuilding footbridge across river on Segment 2.
- Consider options for providing canoeing access somewhere upstream from American Tissue Company.
- Develop informal trail found on Segment 4 into a formal one in connection with land preservation efforts.
- Construct a boardwalk to provide access to wetland area along segment 7.
- Determine feasibility of building a boat launch near the Gardner Municipal Airport.
- Plant vegetated buffers adjacent to harmful land uses to filter out pollutants (especially near Gardner Airport).

Board of Selectmen

- Investigate options for removal of dilapidated structures at American Tissue Plant.
- Investigate Riverside Auto Salvage to see if implementing Best Management Practices.
- Determine whether old trucks are causing any pollution problem. If so, determine if removal is enforceable.
- Discourage dumping near the Gardner Municipal Airport by aggressive patrolling.

2. Tully River

Overall, the Tully River Watershed is in good condition, mostly due to its current rural character. Stream Team priorities are aimed at sustaining the natural resources within the Tully River Watershed. The primary concern of the Stream Team members was the frequent "over-the-bank" dumping of solid waste. Therefore the team has placed high priority on organizing a stream cleanup day in conjunction with the Highway Departments in both the Town of Athol and the Town of Orange. Further priorities are as follows:

Conservation Commissions:

- Town of Athol – Remove siltation barrier at base of closed landfill adjacent to wetlands,
- Clean up solid waste along riverbanks (Town of Athol and Town of Orange),
- Investigate Iron leachate near outfall of drainage pipe at closed landfill (Town of Athol),
- Acquire land easements to develop hiking trails along Tully River.

Army Corps of Engineers

- Develop trails along the Tully River downstream of Tully Lake,
- Investigate land easements or land acquisition to preserve Open Space,
- Improve public access and recreation potential of Tully Dam Recreation Area.

Highway Departments

- Clean up solid waste along riverbanks,
- Remove siltation barrier at base of the closed landfill in Athol,
- Remove road construction materials outside of 200-foot riparian buffer zone.

Department of Environmental Protection

- Improve recreational access for fishing and paddle sports,
- Land acquisition for the protection of Open Space,
- Acquire land easements for hiking trails along the Tully River.

Departments of Public Works

- Organize clean-up days through community, Boy Scouts and river abutter coordination.

B. From the Massachusetts Department of Environmental Protection Nonpoint Source Action Strategy for the Millers River Basin

A number of recommendations were developed by the Massachusetts Department of Environmental Protection following recommendations of the Stream Team reports and a number of other documents. These actions are outlined in Tables VIII-1 and VIII-2. A list of the source documents follows the recommendations. The recommendations are categorized for rivers or lakes, and call for a number of monitoring programs, stormwater sampling and erosion surveys, additional stream walks on tributaries of the Millers and Otter Rivers, mapping of the extent of native and invasive aquatic macrophytes, surveys of lakeshores and surrounding uplands for locations of NPS impairment, investigation of failure rates for septic systems of properties surrounding lakes and ponds, and many others.

Table VIII-1: Massachusetts Department of Environmental Protection
Nonpoint Source Action Strategy Millers River Basin (Final Version July 6, 2001)
Rivers Assessment

Location	Recommended NPS Actions	Implemented Actions
MA 35-01 Millers River from Whitney Pond in Winchendon to the Winchendon Wastewater Treatment Plant (2.0 miles)	• Identify the source of impairment of high PCB and Hg concentrations in fish tissue. (DEP '97 • Include biological monitoring in (support) status. (NPS Coordinator) • Retest for toxics in edible fish tissue for Whitney Pond. (NPS Coordinator) • Conduct NPS survey to assess potential impacts, use Watershed GIS Database from 604b #00-03. (EOEA FY 2002 Annual Work Plan) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan) • Review MWI grant report on PCB Occurrence and Transport, MWI 99-05. (MWI grant summary, 1999).	
MA 35-02 Millers River from Winchendon WWTP to confluence with Otter River (5.3 miles)	• Identify the source of impairment of high PCB and Hg concentrations in fish tissue. (DEP '97) • Retest segment for instream toxicity and fish consumption advisory. (NPS Coordinator) • Include biological monitoring in (support) status assessment. (NPS Coordinator) • Conduct NPS survey to assess potential impacts, use Watershed GIS Database from 604b #00-03. (EOEA FY 2002 Annual Work Plan) • Continue SMART monitoring for: P, DO, pH, nitrates, TKN, TDS, TSS, Microtox, alkalinity, other parameters. (SMART Report Card, Millers) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan)	
MA 35-03 Millers River from Otter River to a USGS gage station in South Royalston (4.8 miles)	• Identify the source of impairment of high PCB and Hg concentrations in fish tissue. (DEP '97) • Include biological monitoring in (support) status assessment.(NPS Coordinator) • Conduct NPS survey to assess potential impacts, use Watershed GIS Database from 604b #00-03 (EOEA FY 2002 Annual Work Plan) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan)	

Location	Recommended NPS Actions	Implemented Actions
MA 35-04 Millers River from the USGS gage station in South Royalston to the Erving Paper Company (17.5 miles)	• Conduct additional monitoring to completely define the use support status of the segment. (DEP '97) • Conduct monitoring to determine sources of impairment. (NPS Coordinator)	• Millers MWI Team funded an assessment project (Phase I) to identify the occurrence and tranpsort of PCBs. (99-05/MWI.) • Phase II PCB assessment study conducted. (00-01/MWI) • Phase III PCB assessment study (ongoing). (01/13-MWI)
MA35-05_1998 Millers River from the Erving Paper Company to the Connecticut River backwater south of French King Bridge Erving	• Conduct additional monitoring to completely assess the use support status in the segment. (DEP '97)	• Millers MWI Team funded an assessment project (Phase I) to identify the occurrence and tranpsort of PCBs. (99-05/MWI) • Phase II PCB assessment study conducted. (00-01/MWI) • Phase III PCB assessment study (ongoing). (01/13-MWI)
MA 35-06 Otter River from wetlands in Hubbardston and Templeton to the outfall at the Gardner Wastewater Treatment Plant (2.6 miles)	• Investigate causes of threatened status to Aquatic Life. (DEP '97) • Include in monitoring; fecal coliform counts and confirm low DO in wetland areas (natural?). (DEP '97) • Conduct NPS survey to assess potential impacts. (Otter River Shoreline Survey) • Investigate two abandoned gravel pits near Riverside Road. (Otter River Shoreline Survey) • Establish vegetated buffer around Snake Pond. (NPS Coordinator)	
MA 35-07 Otter River from the Gardner Wastewater Treatment Plant outfall to the Seaman Paper Company Dam (4.3 miles)	• Additional monitoring to determine frequency and extent of sand and gravel operations (Depot Rd). (DEP '97) • Determine if the "moderate impairment" status of the benthic community is natural. (DEP '97) • Conduct NPS survey to assess potential impacts. (Otter River Shoreline Survey) • Investigate street drain at Hamlet Mill Bridge, moderate flow from paper mill (Seamans). (Otter River Shoreline Survey)	
MA 35-08 Otter River from the Seaman Paper Company to the confluence with Millers River and Trout Brook (5.5 miles)	• Additional monitoring to determine frequency and extent of sand and gravel operations. (DEP '97) • Determine if the "moderate impairment" status of the benthic community is natural. (DEP '97) • Work toward habitat restoration (reestablish riparian buffers at stream-side). (EOEA FY 2002 Annual Work Plan) • Continue SMART monitoring for: P, DO, pH, nitrates, TKN, TDS, TSS, Microtox, alkalinity, other parameters. (SMART Report Card, Millers) • Continue with passive water sampling (and later coring) to determine PCB loads.(EOEA FY 2002 Annual Work Plan) • Implace siltation fence along dirt road near sewer pumping station. (Otter River Shoreline Survey) • CERO to follow-up on "orange goo" pool and contamination at American Tissue Mills (Baldwinville).(Kimball, Brunelle, Rojko 2001.)	

Location	Recommended NPS Actions	Implemented Actions
MA35-09_1998 Beaver Brook From Templeton Developmental Center WWTP to confluence with Millers River, South Royalston	• Assess designated use support. (DEP '97) • Address primary and secondary contact usage. (DEP '97) • Conduct NPS survey to assess potential impacts. (EOEA FY 2002 Annual Work Plan) • Conduct stream walk to identify possible sources of erosion, NPS runoff, and undocumented discharges. (EOEA FY 2002 Annual Work Plan) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan)	
MA35-10_1998 PRIEST BROOK Confluence of Scott and Towne Brooks to confluence with Millers River	• Continue SMART monitoring for: P, DO, pH, nitrates, TKN, TDS, TSS, Microtox, alkalinity, other parameters. (Kimball, 2001) • Conduct NPS survey to assess potential impacts. (EOEA FY 2002 Annual Work Plan) • Provide environmental education opportunities through MRWC Watershed Stewardship Grant. (NPS Coordinator)	
MA-35-13 Lawrence Brook from NH State line to E. Branch Tully Brook	• Conduct stormwater survey to identify possible sources of erosion and NPS runoff. (DEP '97) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan)(• Provide environmental education opportunities through MRWC Watershed Stewardship Grant. (EOEA FY 2002 Annual Work Plan)	• Hydrolab assessment of water quality parameters. (DEP '97)
MA 35-12 East Branch Tully River from Tully Brook and Falls Brook to its confluence with the West Branch in Athol Center (10.5 miles)	• Conduct NPS survey to assess potential impacts and source of PCB/Hg contamination. (DEP '97) • Conduct monitoring for DO, sedimentation, turbidity and bacteria. (DEP '97) • Hydrolab-type assessment of water quality parameters. (EOEA FY 2002 Annual Work Plan) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan) • Inspect leachate at the toe of slope adjacent to the former Athol Town dump. (Tully Stream Team survey report.) • Remove trash (drums, shingles) at Feeder Brook and ponds above gauging station. (Tully Stream Team survey report.) • Organize Boy Scout cleanup near stream (appliances, etc.) at gravel pit, Pinedale Rd. (Tully Stream Team survey report.)	
MA 35-14 Tully River from the confluence of its east and west branches to its confluence with Millers River (1.5 miles)	• Extensive NPS watershed-based monitoring. (DEP '97) • Conduct additional monitoring for PCBs and Hg. (NPS Coordinator) • Conduct stormwater sampling for bacteria. (EOEA FY 2002 Annual Work Plan) • Conduct NPS survey to assess potential impacts. (Tully Stream Team survey report.) • Continue with passive water sampling (and later coring) to determine PCB loads. (EOEA FY 2002 Annual Work Plan) • Consider replacing siltation barrier near Fryeville Rd to gravel pit/dump. (Tully Stream Team survey report.)	

Source: 1997 Millers River Watershed Draft Assessment Report; Massachusetts Department of Environmental Protection.

Table VIII-2: Massachusetts Department of Environmental Protection
Nonpoint Source Action Strategy Millers River Basin (Final Version July 6, 2001)
Lake Assessment

Waterbody	Recommended Actions and Source of Recommendation
North Branch Millers River	
MA35099_1999 Whites Mill Pond Winchendon	• Conduct water quality monitoring. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator
MA35047_1998 Lake Monomonac Winchendon /Rindge, N.H.	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. DEM L&P grant, 2000. • Investigate means to control invasive aquatics besides herbicide use, watershed BMPs, education.
Upper Millers River	
MA35041_1998 Lower Naukeag Lake Ashburnham	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35092_1998 Wallace Pond Ashburnham	• Conduct water quality monitoring. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator
Otter River	
MA35007_1998 Bents Pond Gardner	• Conduct NPS watershed survey to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator
MA35013_1998 Cowee Pond Gardner	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator
MA35029_1998 Hilchey Pond Gardner	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Monitor shoreline for erosion and input stabilization measures where needed. NPS Coordinator • Provide environmental education opportunities through MRWC Watershed Stewardship Grant. EOEA FY 2002 Annual Work Plan

Waterbody	Recommended Actions and Source of Recommendation
MA35034_1998 Kendall Pond Gardner	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Sewer all existing lake residents; a P reduction of 10.5 kg/yr. D/F Study 1991, IEP • Watershed Protection Bylaw (Gardner), protection guidance for future development. NPS Coordinator • Public education to reduce nutrient loads (P-free detergent wastewater). NPS Coordinator • Evaluate effectiveness of sanitary sewer project (L&P grant, 1997). DEM L&P grant 1997
MA35056_1998 Parker Pond Gardner	• Support 319 restoration plan underway at Parker Pond. Tighe & Bond 2000 • Support habitat restoration plan to dredge sediments with ACOE funding. Tighe & Bond 2000, Fugro East 1996 • Provide environmental education opportunities (MRWA) through Watershed Stewardship Grant. EOEA FY 2002 Annual Work Plan • Review Lake Mgt Plan (L&P grant, 1996) for NPS implementation measures. DEM L&P grant, 1996.
MA35062_1998 Ramsdall Pond Gardner	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35104_1998 Wrights Reservoir Gardner Westminster	• Conduct water quality monitoring. NPS Coordinator • Provide detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator
MA35008_1998 Bourn-Hadley Pond Templeton	• Conduct NPS watershed survey to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator NPS Coordinator • Provide environmental education opportunities through MRWC Watershed Stewardship Grant. EOEA FY 2002 Annual Work Plan
MA35010_1998 Brazell Pond Templeton	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator
MA35018_1998 Depot Pond Templeton Winchendon	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator
MA35026_1998 MA35025_1998 Greenwood Pond Templeton Westminster	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator

Waterbody	Recommended Actions and Source of Recommendation
MA35045_1998 Minott Pond South Westminster	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35046_1998 Minott Pond Westminster	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35083_1998 Stoddard Pond Winchendon	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
Middle Millers River	
MA35017_1998 Lake Denison Winchendon	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Investigate septic systems on lake and implement regular pumping schedule. NPS Coordinator
MA35101_1998 Whitney Pond Winchendon	• Conduct water quality monitoring. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Stabilize lakeshore erosion to minimize the mobilization potential of sediments and metals. NPS Coordinator
MA35023_1998 Ellis Pond Athol	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Provide environmental education opportunities through MRWC Watershed Stewardship Grant. EOEA FY 2002 Annual Work Plan • Follow-up/evaluate educational brochure on in-lake and watershed BMPs (L&P grant, 2000). DEM L&P grant, 2000.
MA35063_1998 Reservoir No. 1 Athol	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35093_1998 Ward Pond Athol	• Conduct water quality monitoring. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator
MA35064_1998 Reservoir No. 2 Phillipston Athol	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator

Waterbody	Recommended Actions and Source of Recommendation
Tully River	
MA35005_1998 Beaver Flowage Pond Royalston	• Conduct NPS watershed survey to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. (NPS Coordinator) • Provide environmental education opportunities through MRWC Watershed Stewardship Grant. EOEA FY 2002 Annual Work Plan
MA35071_1998 Royalston Road Pond Orange	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment. NPS Coordinator
MA35089_1998 Tully Pond Orange	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. To determine source of impairment NPS Coordinator
MA35082_1998 Sportsman's Pond Athol	• Conduct detailed mapping of native and invasive aquatic macrophytes.NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator • Assess possible leaching of Pb from lead shot into the pond. Tully Stream Team Report (2000).
Lake Rohunta	
MA35078_1998 South Athol Pond Athol	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35070_1998 Lake Rohunta North Athol Orange	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment. NPS Coordinator
MA35107_1998 Lake Rohunta South Athol/Orange New Salem	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment. NPS Coordinator
MA35065_1998 Riceville Pond Athol Petersham	• Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator • Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring. NPS Coordinator
MA35081_1998 South Spectacle Pond New Salem	•
MA35015_1998 Davenport Pond Petersham Athol	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator

Waterbody	Recommended Actions and Source of Recommendation
Gales Brook	
MA35024_1998 Gales Pond Warwick	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator
MA35028_1998 Hastings Pond Warwick	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator
MA35048_1998 Moores Pond Warwick	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment NPS Coordinator
MA35067_1998 Richards Reservoir Warwick	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment. NPS Coordinator
MA35097_1998 Wheelers Pond Warwick	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine source(s) of impairment. NPS Coordinator
Moss Brook	
MA35035_1998 Laurel Lake Erving Warwick	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment. NPS Coordinator
Lower Millers River	
MA35009_1998 Bowens Pond Wendell	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct detailed mapping of native and invasive aquatic macrophytes. NPS Coordinator
MA35072_1998 Ruggles Pond Wendell	• Conduct NPS survey (watershed and shoreline) to determine sources of impairment. NPS Coordinator • Conduct water quality monitoring to determine sources of impairment. NPS Coordinator

Source: Commonwealth of Massachusetts Department of Environmental Protection, Massachusetts Section 303(d) List of Waters

References

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Massachusetts Dept. of Fish and Wildlife website, "Pond Maps Online".
604b project # 00-03, Millers River Watershed NPS Assessment.
SMART Report Card for the Millers River (in-house with Mass DEP, CERO)
Tighe & Bond 2000, 319 grant-Parker Pond Restoration Project
Tully Stream Team Report (2000).
Otter River Shoreline Survey (Stream Team report, 2000)
Rojko 2000, Kimball 2001, Brunelle 2001, Beaudoin 2001.

C. Action Plan

Recommended Action discussed throughout the text of the report are summarized in Table VIII-3. The plan synthesizes material from the Stream Team efforts and the Massachusetts Department of Environmental Protection Nonpoint Source Action Strategy for the Millers River Basin. Due to time constraints, the plan could not include a ranking of priorities. Funding sources are suggestions. There may be alternative funding mechanisms that are more appropriate to the task. The Action plan should be viewed as a working document and as implementation begins there may be opportunities for revisions to the plan. There may also be relevant material in the body of the report which should be incorporated into the plan, as well.

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
Pollutant Loading Modeling				
1. Investigate land uses in the Otter River Watershed sub-basins to determine: • Whether the hypothetical pollutant loading analysis by Stoltzfuz, that uses nutrient loading coefficients for the Assabet River, is sufficient as a predictive model for the Watershed • What mitigation measures can be implemented to reduce loads of nutrients and suspended solids in the most heavily impacted sub-basins	According to the Stolzfuz research, this is the area in the watershed with the heaviest potential for nutrient loading affecting rivers.	Otter River in Gardner Sub-basins:	• College Internship Program through Natural Sciences Department, • Department of Environmental Protection Oversight	• 319 Program • Ponds and Lakes Program • 604(b) Water Quality Management Planning Grant
2. Calculate nutrient load coefficients and impervious surface coefficients specific to the land uses in the Millers River Watershed. Conduct a Sub-basin Pollutant Loading Analysis using these coefficients.	Dependent upon determination of Step 1	Urbanized areas: Winchendon, Gardner, Templeton, Athol, Orange, Erving	• Department of Environmental Protection • Engineering Consultant • RPAs	• 604(b) Water Quality Management Planning Grant • 319 Program
3. Map the revised model for use in the Lakes Monitoring Program	Dependent upon completion of Step 2		• Department of Environmental Protection • Engineering Consultant • RPAs	• 604(b) Water Quality Management Planning Grant (Develop Model) • 319 Program (analysis)

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
Rivers Assessments				
1. Create Millers River Stream Teams for the Main Stem and its Headwater Branches in Winchendon	Efforts would complement those of the Otter River Stream Team.	Winchendon Athol	• Executive Office of Environmental Affairs Riverways Program • Boards of Health and Conservation Commissions in Templeton, Phillipston, Winchendon, and Athol	Volunteers
2. Establish a Gravel Pit Program to clean up abandoned gravel pits and mitigate potential siltation problems at both active and abandoned gravel operations. Investigate whether operators make use of BMPs.	To be determined	Tully River and Otter River sites	• Boy Scout Cleanup • DEP • Local Boards of Health	• 604(b) Water Quality Management Planning Grant
3. Continue with passive water sampling (and later coring) to determine PCB loads.	To be Determined	Tully River and East Branch Tully River	• EOEA FY 2002 Annual Work Plan • Army Corps of Engineers (ACOE)	• 604(b) Water Quality Management Planning Grant
4. Monitor leachate plumes, orange goo, and plan for future mitigation projects	To Be Determined	East Branch Tully River (Athol Town Dump) American Tissue Mills Winchendon Landfill	• DEP • Millers River Watershed Team	• Volunteer Monitoring Assistance program
5. Continue SMART monitoring for: P, DO, pH, nitrates, TKN, TDS, TSS, Microtox, alkalinity, other parameters.		Priest Brook (MA 35-10-1998) Otter River (MA 35-08)	• EOEA • Millers River Watershed Team	• Volunteer Monitoring Assistance Program

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
(1) Lakes Monitoring Program				
1. Conduct projects to map native and invasive aquatic macrophytes at priority 303d listed lakes and ponds (p. III-8), and cross reference to land uses on the lakeshores.	To be Dtermined	Lakes listed on the 303(d) list. (Table III-2 p. III-8)	• Regional Planning Commissions • Consultant	• Lakes and Ponds Program
2. Cross reference the macrophytes mapping with revised nutrient loading analysis and mapping of failing septic systems from the Septic System Management Plan.	Dependent on outcome of Pollutant Loading Modeling determination.	All lakes listed above with residential land uses	• Regional Planning Commissions • Consultant • Local DPWs	• Lakes and Ponds Program
3. Field check the mapping with volunteer water quality monitoring and shoreline and watershed surveys to determine non-septic sources of excess nutrients.			• Stream Teams • Lake Associations • High School Science Program • College Internship • Regional Planning Commissions	• Lakes and Ponds Program
4. Monitor shoreline for erosion and input stabilization measures where needed to minimize the mobilization potential of sediments and metals.			• Engineering Consultant	

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
Lake Management Plans				
1. Review existing lake management plans for NPS implementation measures.		Lakes listed on the 303(d) list. (Table III-2 p. III-8)	• Regional Planning Commissions • Local Boards of Health	• 604(b) Water Quality Management Planning Grant • Lakes and Ponds Program
2. Support existing mitigation plans, such as the 319 restoration plan and the habitat restoration plan to dredge sediments with ACOE funding, underway at Parker Pond.		Lakes listed on the 303(d) list. (Table III-2 p. III-8)	• Watershed Team • Local DPW • DEP	• 319 Program
3. Investigate means to control invasive aquatics besides herbicide use.		Lakes listed on the 303(d) list. (Table III-2 p. III-8)	• Conservation Commissions • DPWs	• Lakes and Ponds Program • 319 Program
4. Develop a Septic System Management Plan for residential lakes. • Evaluate effectiveness of previous sanitary sewer projects. • Investigate septic systems on residential lakes and implement regular pumping schedule. • Determine failure rates for lakeside septic systems and investigate the need for infrastructure improvement. • Map locations of failing septic and sewer systems • Provide Sewer Systems for residents of lakes where feasible to achieve a Phosphorus reduction of 10.5 kg/yr. (IEP)		Lakes listed on the 303(d) list that have residential land uses. (Table III-2 p. III-8)	• Local Boards of Health • RPAs	• 319 Program • EOEA Lakes and Ponds Grant Program • Community Development Block Grants

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
(2) Education Programs				
1. Provide environmental education opportunities targeted at areas identified through the mapping projects and the revised nutrient loading analysis.	To be Determined	Local Communities	• EOEA FY 2002 Annual Work Plan • Stream Teams • Millers River Environmental Center	• EPA Environmental Education Grant Program • Watershed Stewardship Grant • Natural Resources and Environmental Conservation, UMass Extension • Fund for Preservation of Wildlife and Natural Areas
2. Develop public participation process for setting priorities for TDML development.	To be Determined	Local Communities	• Watershed Team • Millers River Environmental Center	• Lakes and Ponds Program • 604(b) Water Quality Management Planning grant
3. Use the public participation process and the mapping projects to rank the importance of each waterbody in the watershed, the water quality impairment, and the availability of mitigation methods	To be Determined	Local Communities	• Watershed Team • Millers River Environmental Center	• Lakes and Ponds Program • 604(b) Water Quality Management Planning grant
4. Publish a manual of Watershed Best Management Practices to serve as the foundation for education efforts. Include methods to reduce nutrient loads, such as use of phosphorus free detergents aimed at owners of lakeside septic systems.			• BMPs available from EPA, DFA, MADEP, MA Forestry Association, Mass Association of Conservation Commissioners	• EPA Environmental Education Grant Program • Mass Association of Conservation Commissioners
5. Link landowner education programs to monitoring of water quality, nutrient loads, and presence of noxious aquatic plants to determine the effectiveness of the programs and to foster community participation in the health of the lakes.			• Stream Teams • Lake Associations • DEP/EOEA	• EPA Environmental Education Grant Program • Lakes and Ponds Program • 604(b) Water Quality Management Planning grant

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
Watershed Protection Zoning				
1. Conduct a comprehensive comparison of zoning practices, to evaluate the effectiveness of the language each community has adopted (regarding Surface and groundwater resource areas, Parking dimension regulations, Lot Size Dimension Regulations, Open Space Residential Design, Use Regulations) and identify specific areas for improvement. Include impacts anticipated by the EOEA buildout analysis.	To be Determined	All Towns	• Regional Planning Commissions • Consultant • Local communities • Vote at Town Meeting	• Local Funding • EOEA Regional Open Space Plan Project
2. Map zoning districts for the entire watershed to maps of the water resources, nutrient load model, and identified water quality problems to target specific zoning district improvements.	To Be Determined	All Towns	• Regional Planning • Consultant • Local communities • Vote at Town Meeting	• Local Funding • EOEA Regional Open Space Plan Project
3. Develop a continuing watershed protection zoning education program aimed at improving voter awareness of zoning impacts on water quality. Conduct surveys of participants as a measure of effectiveness. Include impacts anticipated by the EOEA buildout analysis.	To Be Determined upon completion of Step 2.	All Towns	• Citizen Planner Training Collaborative • RPAs • Consultant • Local communities • Vote at Town Meeting	• Local Funding • EOEA Regional Open Space Plan Project
4. Recommend changes to local general and zoning bylaws and subdivision regulations for each affected community for voters to take action at Town Meetings. Update the procedure annually. • Water Supply Protection Overlay Bylaw • Hazardous Materials Bylaw • Underground Storage Tank Bylaw • Impervious Cover Bylaw • Environmental Impact Analysis • Wetlands Bylaw • Protection of Watercourses in Recharge Areas • Septic System Regulations • Eosion/Sediment Control • Upland/Slope Protection • Open Space Residential Design	To be determined upon review of surveys in Step 3	All Towns	• Regional Planning Commissions • Consultant • Local communities • Vote at Town Meeting	• Local Funding • EOEA Regional Open Space Plan Project

TableVIII-3: Action Plan for Addressing Nonpoint Source Pollution in the Millers River Watershed

Action	Severity	Location	Lead Agencies Participants	Funding
Stormwater Management				
1. Investigate existing stormwater management systems (infrastructure and road salt policy) in place on highways and local road networks to determine the extent to which stormwater runoff discharges directly into wetlands and waterbodies.	Particularly important on heavily traveled roads.	• All Bridges prioritized in the Scour Assessment database discussed on p. IV-31. • All other bridges as practical	• Local DPW's • MassHighway	• 604(b) • MassHighway (3C, PL, SPR, Enhancements)
2. Devise a plan for mitigating the identified stormwater direct discharges.	Dependent upon Step 1		• Local DPW's • MassHighway	• 604(b) • Local Funding • MassHighway (3C, PL, SPR, Enhancements)
3. Develop local stormwater management regulations that apply principals of the new Federal Phase II Stormwater Regulations (which do not apply in the Millers River Watershed, since the population densities are below the threshold).	Considered in Highway Design Manual, Subdivision Regulations, and Site Plan Review. Depends on development pressure.	• All areas experiencing growth pressure • All urbanized areas	• Local DPW's, • MassHighway • RPAs • Vote at Town Meeting	
4. Assign jurisdictional responsibility for currently unaccepted unpaved roads.	12% of unpaved roads. If towns accept jurisdiction this would increase their responsibility by 18% overall.	As listed in Table IV-17 on p. IV-29	• Local DPW's • MassHighway • ACOE • DEM • Private Landowners	
5. For all unpaved roads, implement the Best Management Practices described in the Unpaved Roads BMP Manual by the Berkshire Regional Planning Commission, MA DEP, and EPA		As listed in Table IV-17 on p. IV-29	• Local DPW's • MassHighway • ACOE • DEM • Private Landowners	• 319 Program • State/Federal Aid Local Aid Programs

Appendices

Appendix A
Vernal Pool Certification

The Massachusetts Natural Heritage and Endangered Species Program has issued guidelines for vernal pool certification. The following are five sets of conditions that would indicate that a water body or depression is a vernal pool. Methods A and B identify a vernal pool by the "obligate species", those which require the fish-free yet temporary waters of a vernal pool for their life cycle. Methods C, D, and E identify a vernal pool by demonstrating that it has no fish yet does have "facultative species", those organisms which require a few months of water for their life cycle.

Wet pool - obligate species

A. Existence of a confined basin depression and evidence of breeding in standing water by any of the following amphibian species (these species breed only in vernal pools):

- Wood Frog (Rana sylvatica)
- Spotted Salalmander (Ambystoma maculatum)
- Blue-spotted Salamander (Ambystoma laterale)
- Jefferson Salamander (Ambystoma jeffersonianum)
- Silvery Salamander (Ambystoma "platineum")
- Tremblay's Salamander (Ambystoma "tremblayi")
- Marbled Salamander (Ambystoma opacum)

B. Existence of a confined basin depression and the presence of fairy shrimp (Anostraca) or their eggs therein. These species spend their entire life cycles in vernal pool habitat.

Wet pool - facultative species

A. Existence of a confined basin depression that contains standing water that dries up during the year (or which for other reasons is free of adult fish populations) and the presence of two or more of the following in standing water (these species are not found in water that persists for less than two continuous months in the spring and/or summer):

- Breeding spring peepers (Hyla crucifer)
- Breeding green frogs (Rana clamitans)
- Breeding Fowler's toads (Bufo woodhousii fowleri)
- Adult red-spotted newts (Notophthalum viridescens)
- Painted turtles (Chrysemys picta)
- Water scorpions (Nepidae)
- Whirligig beetle larvae (Gyrinidae)
- Caddisfly larvae (Trichoptera)
- Damselfly larvae (Odonata, Zygoptera)
- Breeding gray treefrogs (Hyla versicolor)
- Breeding American toads (Bufo americanus)
- Breeding four-toed salamanders (Hemidactylium scutatum)
- Spotted turtles (Clemmys guttata)
- Snapping turtles (Chelydra serpentina)
- Predaceous diving beetle larvae (Dytiscidae)
- Dobsonfly larvae (Corydalidae)
- Dragonfly larvae (Odonata, Anisoptera)
- Leeches (Hirudinea)

Dry pool - - facultative species

A. Existence of a confined basin depression which lacks standing water or which contains standing water the dries up during the year (or is otherwise free of adult fish populations) and the presence of one or more of the following (a,b,or c) (these species are found only in areas that contain water for at least two continuous months in the spring and/or summer):

a. Cases of caddisfly larvae (Trichoptera)
b. Adults, juveniles or shells of either Freshwater clams (Pisidiidae) or Amphibious air-breathing snails (Basommatophora)

c. At least six of the following wetland plant species:

- Duckweeds (Lemna spp., Spirodela spp., Wolffia spp.)
- Fountain moss (Fontinalis spp.)
- False mermaid weeds (Proserpinaca palustris and P. pectinata)
- Bur-reeds (Sparganium androcladum and S. chlorocarpum)
- Buttonbush (Cephalanthus occidentalis)
- Pondweeds (Potamogeton spp.)
- Bladderworts (Utricularia clandestina, U. gibba and U. subulata)
- Water-milfoils (Myriophyllum humile and M. tenellum)
- Water plantain (Alisma plantago-aquatica)
- Yellow water-crowfoot (Ranunculus flabellaris)
- Featherfoil (Hottonia inflata)
- Water-starworts (Callitriche spp.)
- False pimpernels (Lindernia anagallidea and L. dubia)
- Lance-leaved violet (Viola lanceolata)
- St. John's-worts (Hypericum adpressum, H. boreale, H. canadense, and H. mutilum)
- Smartweeds (Polygonum amphibium, P. hydropiper, P. hydropiperoides, P. pensylvanicum and P. punctatum)
- A rush (Juncus pelocarpus)
- Sedges (Rhynchospora capitellata and R. fusca)
- Grasses (Agrostis scabra, Glyceria acutiflora, G. canadensis, G. fernaldii, G. pallida, Muhlenbergia uniflora, Panicum dichotomiflorum, P. meridionale, P. philadelphicum, P. rigidulum, P. tuckermanii, P. verrucosum)

Wet /dry pool - - combination of obligate/facultative species
E. Existence of all of the following:
1. Documented presence of water in a confined basin depression for at least two continuous months in the spring and/or summer; and
2. Confirmation that the vernal pool area becomes completely dry during a portion of the year (or other documentation proving the absence of adult fish populations); and
3. Presence of any amphibians and/or reptiles in standing water within the confined basin depression.

Definitions:
Breeding evidence. The presence of any of the following will be considered an acceptable proof that a vernal pool is utilized for breeding purposes by one or more specific amphibian species:

1. Breeding adults
Frog or toad - - breeding chorus and/or mated pairs
Mole salamanders - - courting individuals and/or spermatophores
2. Two or more egg masses of any of the amphibian species
3. Frog or toad tadpoles or mole salamander larvae
4. Transforming juveniles
Frog or toad - - tail stubs evident
Mole salamanders - - gill remnants evident
Confined basin depression. A confined basin depression is low area which collects water. It must not have a permanent above ground outlet.

Appendix B

ACEC Nomination Process

A group of ten citizens; a conservation commission, planning board, board of selectmen, mayor or city council; a regional or state agency; or a state legislator may submit an ACEC nomination. Most often, a group of ten citizens prepares an ACEC nomination, with support from the municipal boards and commissions of the communities affected.

The basic materials required for a nomination are:

1. A description of the resources of the nominated area;
2. A map showing proposed boundaries; and
3. An explanation of why the area should be designated.

In practice, however, much more information, public education, and outreach are required to nominate an area. More specific information should include:

- Details and available maps regarding specific resources and their significance;
- An overview and description of the ecological relationships of the resources of the area;
- A written description of the proposed boundary, and a detailed explanation of why the specific boundary is proposed based on the resources and ecology of the area;
- A brief description of the process of public education and outreach that has been undertaken, and public support for the nomination;
- An explanation of why the area should be designated, using the criteria listed in the ACEC regulations at 301 CMR 12.09; and
- A general description of *planning and management goals* for the nominated area after designation, and *potential mechanisms for implementation and follow-up of a designation.*

For example, planning and management goals might include improving state and local coordination regarding specific resource issues, protecting additional key open space areas, or monitoring water quality and rare species habitats. Implementation mechanisms could include establishing a permanent regional planning and management committee, or developing an environmental education program with area schools and universities.

All of the tasks in preparing an ACEC nomination can be undertaken by ordinary citizens and residents, compiling and assembling existing information from a variety of sources at minimal cost. In fact, historically, nominations have been prepared in this manner. ACEC Program staff will provide technical assistance regarding the contents and process of preparing a nomination, as well as details regarding the review and the purpose and effects of ACEC designation.

Appendix C

Hazardous Waste Facilities

Appendix D
Pollutant Loading Analysis by Subbasin

Appendix E

Public Participation Process

Press releases
Flyers
Contacts
Shoreline Training Attendees
Stream Teams
Letters to Abutters
Shoreline Surveys
Photos

JUNE 15, 2000

PRESS RELEASE

RELEASE DATE: IMMEDIATELY

CONTACT PERSONS: JOHN HUME, (978) 343-9667
LAURIE CONNORS (978) 343-3317

MILLERS RIVER WATERSHED NONPOINT SOURCE ASSESSMENT

The Montachusett Regional Planning Commission (MRPC) recently received a $57,500.00 grant from the state's Department of Environmental Protection to conduct a Millers River Watershed Nonpoint Source Assessment. To strengthen the effectiveness of the project while serving a wider geographic area, the Montachusett Regional Planning Commission (MRPC) will be working together with the Franklin Regional Council of Governments (FRCOG) to create a solid information base, to guide future governmental and private actions to reduce non-point source pollution, and improve and ensure a high level of water quality in the Millers River Watershed.

The Millers River is located in Northern Central Massachusetts with approximately 20% of the watershed extending into the southern section of New Hampshire. The total drainage area in Massachusetts is 313 square miles consisting of seventeen municipalities populated by approximately 87,000 people. Communities included in this particular project are Ashburnham, Ashby, Athol, Erving, Gardner, Hubbardston, Orange, Phillipston, Royalston, Templeton, Warwick, Wendell, Westminster and Winchendon. The highest population concentrations are in the communities of Athol, Orange, and Gardner.

Originally the waters of the Millers River were full of salmon, trout and other fish. European settlement of the region in the seventeenth century, with its accompanying development of dams and mills, began to change the quality and character of the water. In the 1930's and 1940's the river was still one of the best-stocked streams in the state. However, by the 1950's pollution from industrial and domestic sources had ruined the Millers for fishing and recreation. In the 1970's the local watershed council began orchestrating a cleanup. By 1983, the river was clean enough to stock again. However, pollution from PCB's, chlorination, heavy metals, erosion, landfill leachate, storm water runoff and acid rain continue to plague the watershed. Fish consumption advisories have been issued on most of the river and on selected lakes.

The purpose of this project is to identify potential non-point sources of contaminants in the Millers River Watershed. As water moves through the watershed towards the drainage point in the form of runoff, it picks up sediments, nutrients and other materials and deposits them elsewhere in the watershed or discharges them from the system. However, this runoff can also pick up contaminants that are hazardous to the watershed. Together, MRPC and FRCOG will use MassGIS data layers, state reports, community input, and field work to identify potential non-point sources of pollution, and create a watershed action plan that will incorporate Millers River Watershed Basin Team and Millers River Watershed Council goals. The Millers River Watershed supplies high quality drinking water to much of the region. The Watershed is also a part of the Connecticut River Drainage system which forms an integral part of the water supply system leading to the major metropolitan areas in and around Boston and provides a home to several endangered species.

OCTOBER 27TH, 2000

PRESS RELEASE

RELEASE DATE: IMMEDIATELY

CONTACT PERSONS: JOHN HUME, (978)343-9667
LAURIE CONNORS (978)343-3317

KICK-OFF CELEBRATION
FOR MILLERS RIVER WATERSHED NONPOINT SOURCE ASSESSMENT

A Millers River Watershed Non-Point Source Assessment Kick-Off Celebration is scheduled for November 2nd, 2000 from 6:30 to 9:00 P.M. at Harvard Forest, Fisher Museum, Petersham, MA. Refreshments will be provided.

The Montachusett Regional Planning Commission (MRPC) received a $57,500.00 grant from the state's Department of Environmental Protection to conduct a Millers River Watershed Non-point Source Assessment Project. To strengthen the effectiveness of the project while serving a wider geographic area, the Montachusett Regional Planning Commission (MRPC) is working with the Franklin Regional Council of Governments (FRCOG) and the Millers River Watershed Council.

The purpose of this project is to identify potential non-point sources of contaminants in the Millers River Watershed. As water moves through the watershed towards the drainage point in the form of runoff, it picks up sediments, nutrients and other materials that may prove hazardous to the overall health of rivers, lakes and ponds. Excessive algae and weed growth is indicative of an abundance of non-point source pollutants, and limits the recreational opportunities of lakes and ponds. Under this project, potential problems will be identified and solutions for mitigating those problems formulated. Communities included in this particular project are Ashburnham, Ashby, Athol, Erving, Gardner, Hubbardston, Orange, Phillipston, Royalston, Templeton, Warwick, Wendell, Westminster and Winchendon.

Public participation is key to the success of this project. Volunteers are needed to perform a shoreline survey along sections of the Otter and Tully Rivers, both of which are located within the Millers River Watershed. We hope that landowners, students, wildlife enthusiasts, sportsmen, professionals, elected officials, community volunteers, and others will attend the Kick-Off Celebration to learn more about and help identify non-point sources of pollution in the area. For more information call John Hume (978) 343-9667 or Laurie Connors (978)343-3317 at MRPC Offices located in Fitchburg, MA.

NOVEMBER 13, 2000

PRESS RELEASE

RELEASE DATE: **IMMEDIATELY**

CONTACT PERSONS: **JOHN HUME, (978) 343-9667**
LAURIE CONNORS (978) 343-3317

SHORELINE SURVEY TRAINING SESSION FOR
THE MILLERS RIVER WATERSHED NONPOINT SOURCE ASSESSMENT PROJECT

As part of the Millers River Watershed Nonpoint Source Assessment Project, stream teams are currently being formed to act as river stewards. In a first step, volunteers will participate in a visual shoreline survey to assess the condition of two major tributaries to the Millers River- the Otter River and the West Branch of the Tully River. To accomplish this survey, volunteers will access the water via nearby roads and either walk or canoe down the rivers, observing and recording important instream and land use characteristics. Already, citizens from throughout the watershed have agreed to participate in this important, fun-filled activity. But, more people are needed!

Anyone interested in learning more about their watershed and/or the natural environment are encouraged to attend the shoreline survey training session which will be held this Thursday, November 16th, from 6:30 to 8:00 pm at the Millers River Environmental Center at 100 Main Street in Athol. The training session is being sponsored by the Montachusett Regional Planning Commission and the Franklin Regional Council of Governments, who have joined forces with the Millers River Watershed Coalition and the Massachusetts Adopt-A-Stream Program in an effort to protect and restore the Millers River.

For further information please contact Laurie Connors at the Montachusett Regional Planning Commission, R1427 Water Street, Fitchburg, MA 01420, (978) 343-3317, or through e-mail at lconnors@mrpc.org.

NOVEMBER 22, 2000

PRESS RELEASE

RELEASE DATE: **IMMEDIATELY**

CONTACT PERSONS: **JOHN HUME, (978) 343-9667**
LAURIE CONNORS (978) 343-3317

VOLUNTEERS TO REPORT ON SHORELINE SURVEY FINDINGS

On November 16, approximately forty volunteers met at the Millers River Environmental Center to learn about conducting a Shoreline Survey. Amy Singler, of Massachusetts Adopt-A-Stream Program guided the group through the process using her slide presentation. The volunteer river stewards formed teams and selected different sections of the Tully and Otter Rivers, two major tributaries of the Millers River. Each team was provided with maps and guide sheets and was enthusiastic to get into the field. Over the course of the next two weeks, these teams will access their section by walking stretches of shoreline or traveling by boat down these rivers, observing and recording important in-stream and land use characteristics.

On Thursday, December 7th from 6:30 to 8:00pm, teams will report their findings. That meeting will be held at the Millers River Environmental Center, 100 Main Street in Athol. If you missed our organizational meeting, but have an interest in joining these eager volunteer river stewards, please attend this public meeting. More activities are planned, more volunteers are needed, and more river remains to be explored!

This Shoreline Survey reporting session is sponsored by the Montachusett Regional Planning Commission and the Franklin Regional Council of Governments, who have joined forces with the Millers River Watershed Council, the Athol Bird and Nature Club, and the Massachusetts Adopt-A-Stream Program in an effort to protect and restore the Millers River.

For further information please contact Laurie Connors at the Montachusett Regional Planning Commission, R1427 Water Street, Fitchburg, MA 01420, (978) 343-3317, or through e-mail at lconnors@mrpc.org.

DECEMBER 8, 2000

PRESS RELEASE

RELEASE DATE: IMMEDIATELY

CONTACT PERSONS: LAURIE CONNORS (978) 343-3317
JOHN HUME, (978) 343-9667

VOLUNTEERS SHARE SHORELINE SURVEY FINDINGS

On December 7th, approximately thirty volunteers gathered at the Millers River Environmental Center in Athol to share the results of their shoreline surveys. During the past two weeks, river stewards observed and recorded important in-stream and land use characteristics along the Tully and Otter Rivers. After receiving training from Amy Singler, of Massachusetts' Adopt-A-Stream Program, the volunteers explored the rivers by walking along shorelines or traveling via boat down the rivers.

The breathtaking beauty of the rivers moved many of volunteer surveyors. Wildlife, including a variety of birds, beaver, muskrat, fox, deer, and moose, abound. Invasive plants, such as purple loosestrife and phragmites do not yet plague riverbanks and adjacent wetlands as they do throughout Massachusetts. Historic features dot the landscape, offering exciting opportunities for interpretive trails.

The rivers are not without problems, however. The lack of accessibility prevents many from enjoying their natural beauty and limits recreational opportunities. Residential dumping and the remnants of industrial activity mar a few places. One observer noted a "pool of orange goo" that most likely reaches the river at times of heavy rainfall. Erosion is a problem in areas and scattered, delapidated structures pose risks to public health and safety.

On Thursday, January 18th from 6:30 to 8:00pm, the Tully and Otter River teams will meet once again to forge a plan of action. That meeting will be held at the Millers River Environmental Center, 100 Main Street in Athol. If you missed the last few meetings, but have an interest in joining these eager volunteers, please attend this very important meeting. More volunteers are needed and activities planned. We need your help to make a difference!

This Shoreline Survey reporting session was sponsored by the Montachusett Regional Planning Commission and the Franklin Regional Council of Governments, who have joined forces with the Massachusetts Adopt-A-Stream Program, Executive Office of Environmental Affairs Millers River Basin Team, Millers River Watershed Council, City of Gardner, Stony Bridge Foundation, and Athol Bird and Nature Club, in an effort to protect and restore the Millers River.

For further information please contact Laurie Connors at the Montachusett Regional Planning Commission, R1427 Water Street, Fitchburg, MA 01420, (978) 343-3317, or through e-mail at lconnors@mrpc.org.

JANUARY 11, 2001

PRESS RELEASE

RELEASE DATE: IMMEDIATELY

CONTACT PERSONS: LAURIE CONNORS (978) 343-3317

RIVER VOLUNTEERS TO FORGE ACTION PLAN

Do you want to improve the quality of local rivers, lakes and ponds? Do you want to work towards protecting land for wildlife habitat and recreation purposes? Do you want to make local rivers and streams more accessible for recreational boating, fishing, swimming, hiking, and nature observation? Are you interested in making a meaningful difference in the Millers River Watershed? If you answered yes to any of these questions, come share your ideas at the very important Action Planning Meeting for the Tully and Otter River Stream Teams. The meeting is scheduled for 6:30 on Thursday evening, January 18th, at the Millers River Environmental Center at 100 Main Street in Athol. Amy Singler and Rachel Calabro of the Massachusetts' Adopt-A-Stream Program will facilitate the meeting. All are welcome to attend. We need your help to make a difference!

This Action Planning meeting is sponsored by the Montachusett Regional Planning Commission and the Franklin Regional Council of Governments, who have joined forces with the Department of Environmental Protection, Massachusetts Adopt-A-Stream Program, Millers River Watershed Team, Millers River Watershed Council, City of Gardner, Stony Bridge Foundation, and Athol Bird and Nature Club, in an effort to protect and restore the Millers River and its tributary streams.

For further information please contact Laurie Connors at the Montachusett Regional Planning Commission, R1427 Water Street, Fitchburg, MA 01420, (978) 343-3317, or through e-mail at lconnors@mrpc.org.

Find Out What's Happening in Your Watershed!

Millers River Watershed
Shoreline Survey Training Session
on
Thursday, November 16th 2000
6:30 pm to 8:00 pm

Millers River Environmental Center
100 Main Street
Athol, Massachusetts

We Need Your Help!
Come One, Come All!

Prepared 7/30/02 by
Montachusett Regional Planning Commission
Franklin Regional Council of Government

Millers River NPS Assessment Contact List

Athol

1. Walter Lehmann, Conservation Commission, (978) 249-9164
2. Lisa Aldrich, Assessors Office, (978) 249-3880 (work), (978) 249-9731 (home)
3. Jim White, Selectman, (978) 544-5335 (work), (978) 249-0116 (home)
4. Elwin Bacon, Conservation Commission, (978) 249-2004
5. Mary Forristall, Selectman, (978)249-0005 (work), (978) 249-7991
6. Kent Strong, School Committee, (978) 249-2435 (work), (978) 249-6066
7. Mike King, School Committee, (978) 249-2430 (work), (978) 249-6147
8. JR Greene, Conservation Commission, (978) 249-9376
9. Patricia Roix, YMCA and School Committee, (978) 249-3305
10. Pamela Mendoza, Teen Task Force, (978) 249-3396
11. Mel Talbot, Recreation Commission, (978) 249-3633 (work), (978) 249-7665
12. Robert Muzzy, Conservation Commission, (978) 249-2400 (work), (978) 249-3734 (home)

Millers River Watershed NPS Assessment

Attended Kickoff:	Attended Shoreline Training:
1. Vyto Andreliunas, (978) 249-7341, vytoa@net1plus.com	1. Larry Barrieau, (978) 297-4713
2. Ron Cloutier, (978) 544-7500, cloutier@tiac.net	2. Earle Baldwin, (978) 249-0959, earlebaldwin@hotmail.com
3. Sue Cloutier, (978) 544-7500	3. * Ron Cloutier, (978) 544-7500
4. Laurie Connors, (978) 343-3317	4. * Sue Cloutier, (978) 544-7500
5. Alexandra Dawson, (413) 586-5586 *(SPEAKER)*	5. * Laurie Connors, (978) 343-3317
6. Joe Dunn, (413) 774-2251	6. * Joe Dunn, (413) 774-2251
7. Brian Duvall, (508) 849-4027 *(SPEAKER)*	7. * Glenn Eaton, (978) 348-2490
8. Glenn Eaton, (978) 348-2490	8. * Victoria Eaton, (978) 348-2490
9. Victoria Eaton, (978) 348-2490	9. Steve Farrell, (978) 630-3667
10. Pat Fellows, (978) 249-5852	10. Rachel Horowitz, (978) 544-3282, rachel@bio.umass.edu
11. Bob Gray, (978) 249-3460	11. * Rob Hubbard, (978) 630-4014
12. John Henshaw, (978) 939-5744	12. * John Hume, (978) 343-9667
13. Bonnie House, (978) 249-3444	13. * Ernie King, (978) 630-5410
14. Rob Hubbard, (978) 630-4014	14. Jessi Manty, (978) 939-2425
15. John Hume, (978) 343-9667	15. Sharon Manty, (978) 939-5966
16. Dr. Ward Hunting, (978) 544-3363	16. Gregory McGuane, (978) 249-8904
17. Warren Kimball, (508) 792-7621	17. * Laila Michaud, (978) 345-7376 ext. 2245
18. Ernie King, (978) 630-5410	18. Dan Nolan, (978) 249-4443
19. Laila Michaud, (978) 345-7376 ext. 2245	19. Rick Paquette, (978) 939-1101
20. John O'Keefe, (978) 724-3302	20. Tracey Paquette, (978) 939-1101
21. Mason Phelps, (978) 544-2735	21. * Mason Phelps, (978) 544-2735
22. Alice Rojko, (508) 792-7470 ext. 3855	22. * Alice Rojko, (508) 792-7470 ext. 3855
23. Walter Rolf, (978) 939-8000	23. * Joyce Rychuk, (978) 249-6832
24. Joyce Rychuk, (978) 249-6832	24. Bruce Scherer, (978) 544-3282
25. Amy Singler, (617) 626-1548 *(SPEAKER)*	25. * Amy Singler, (617) 626-1548 *(SPEAKER)*
26. David Small, (978) 249-2054, dhsmall@gis.net	26. * David Small, (978) 249-2054
27. Larry Snider, (978) 874-0591	27. Don Stone, (978) 544-3594
28. Bob Svorsky, (978) 498-0094	28. Ann Townsend, (978) 724-8806, anntownse@aol.com
29. Rich Turcotte, (978) 632-1748	29. Ralene Williams, (978) 249-9437
30. Jim White, (978) 544-5335, jim@whitie.com	30. Greg Wright, (978) 575-0557
	31. Michaele Wright, (978) 575-0557

* Attended both the Kickoff and the Shoreline Survey Training

Expressed Interest but Have Not Attended Meetings:

Deforest Bearse, (978) 297-5410
Tom Driskell, t.driskell@net1plus.com
Shelly and Tom Hatch, (978) 343-0377

Otter River Stream Team

Definite Members:

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Tully River Stream Team

Definite Members:

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Sue Cloutier, (978) 544-7500
Dave Small, (978) 544-6343
Jim White, (978) 249-0116

Letter to Otter River Abutters

November 9, 2000

Dear Neighbor of the Otter River,

You may have read in one of the local papers recently that the Montachusett Regional Planning Commission, Franklin Regional Council of Governments, Millers River Watershed Council, and citizens from fourteen watershed communities have joined together to protect and restore the Millers River. As a landowner of property along the Otter River, a major tributary to the Millers River, we invite you to join us in our efforts and participate in a visual survey aimed at identifying possible sources of contamination.

In an effort to pinpoint possible pollutants at their source, volunteers from fourteen communities have agreed to monitor and assess the condition of two major tributaries to the Millers River, the Otter and Tully Rivers. As a first step in this effort, volunteers will participate in a visual Shoreline Survey of the Otter River as it flows to the Millers River from November 17th to December 7th. To accomplish this survey, volunteers will access the water via nearby roads and then either walk or canoe down the river, observing and recording important in-stream and land use characteristics. Care will be taken not to traverse any private property, but it may be necessary to walk along the river's banks in certain areas to avoid trampling wetland habitat.

If you have any questions or concerns regarding this Shoreline Survey Program, please contact me at (978) 343-3317. To participate in the Shoreline Survey, please join us at the training session to be held on Thursday, November 16th, from 6:30 to 8:00 pm at the Millers River Environmental Center at 100 Main Street in Athol.

Thank you for your time, and we hope to work with you in the future.

Sincerely,

Laurie A. Connors
Regional Planner

Otter River Abutters

Mr. Anthony Manca, Trustee, PO Box 216, Gardner, MA 01440,
New England Gas and Oil Hauler, Inc., PO Box 120011, Stamford, CT 06912-0011,
Mr. and Mrs. John H. Cummings, 160 Bridge Street, Gardner, MA 01440,
Ms. Florence Stuckey, 185 Bridge Street, Gardner, MA 01440,
Mr. and Mrs. Roland A. Broeckel, 179 Bridge Street, Gardner, MA 01440,
Mr. and Mrs. Randall A. Swenson, 163 Bridge Street, Gardner, MA 01440,
Mr. and Mrs. Thomas E. Cook, 168 Bridge Street, Gardner, MA 01440,
CM Realty Inc., 14 Whipple Street, Berkley, RI 02864,
Mr. Henri M. Lepkowski, 330 Coleman Street, Gardner, MA 01440,
Mr. and Mrs. Kevin Barry Smith, 632 Parker Street, Gardner, MA 01440,
Mr. and Mrs. Richard F. Drew, 621 Parker Street, Gardner, MA 01440,
Ms. Brenda M. Champney, 65 Riverside Road, Gardner, MA 01440,
Mr. Gardner E. McPherson Jr., 77 Riverside Road, Gardner, MA 01440,
Mr. Ronald L. Cormier, 109 Riverside Road, Gardner, MA 01440,
Mr. and Mrs. John E. Dikson, 176 Riverside Road, Gardner, MA 01440,
Adolf Jandris and Sons, Inc., C/O W.C.N.B., 202 High Street, Gardner, MA 01440,
Ms. Mary Fedeli, C/O David Fedeli, 52 South Nelson Road, Sterling, MA 01568,
Ms. Rebecca A. Gerry, 56 Glenwood Street, Gardner, MA 01440,
Nantucket Land and Mtge. Co. Inc., 297 North Street, Hyannis, MA 02601,
Mr. Anthony Cosentino, PO Box 141, East Templeton, MA 01438,
Mr and Mrs. Henry Bankowski, 231 Fifth Avenue, Melbourne, FL 32951,
Mr. Kenneth Rameau, 111 Green Street, Gardner, MA 01440,
Mr. and Mrs. Chester Pernerewski, PO Box 324, East Templeton, MA 01438,
Mr and Mrs. Mark Morse, PO Box 66, East Templeton, MA 01438,
Mr and Mrs. Barry Fadden, PO Box 257, East Templeton, MA 01438,
Mr. Eric Morse, 115 Depot Road, East Templeton, MA 01438,
W.J. Graves Construction Company, Inc., PO Box 401, East Templeton, MA 01438,
The Fletcher Trust No. 1, 19 Walnut Road, Otter River, MA 01436,
Mr. and Mrs. William Leighton, 55 Turner Street, Templeton, MA 01468,
Mr. and Mrs. Juan Mendoza, 56 Turner Street, Otter River, MA 01436,
Mr. and Mrs. Maurice Morneault, 52 Hamlet Mill Road, Otter River, MA 01436,
Ms. Christine Martines, 60 Hamlet Mill Road, Otter River, MA 01436,
Ms. Alice Newton, 66 Hamlet Mill Road, Otter River, MA 01436,
Mr. and Mrs. Valmore Caran, 128 Main Street , Otter River, MA 01436,
Mr. and Mrs. Knowlton, 32 Pine Drive, Otter River, MA 01436,
Mr. Gerene Hamel, Life Estate, 411A State Road, Otter River, MA 01436,
Mr. and Mrs. Jerry Willis, 26 Pine Drive, Otter River, MA 01436,
Mr. and Mrs. Mark McDonald, 21 Hamlet Mill Road, Otter River, MA 01436,
Mr. and Mrs. Raymond LeBlanc, 47 Hamlet Mill Road, Otter River, MA 01436,
Mr. and Mrs. Peter Brodeur, 59 Hamlet Mill Road, Otter River, MA 01436,
Mr. and Mrs. Robert Gale, 82 Main Street, Otter River, MA 01436,
Seaman Paper Company of MA, PO Box 21, Otter River, MA 01436,
Mr. and Mrs. John Howard, 11 River Road, Otter River, MA 01436,
Mr. and Mrs. Alexander Sawicki, 13 River Road, Otter River, MA 01436,
Mr. and Mrs. Todd Ziemke, 21 River Road, Otter River, MA 01436,
Mr. William O'Brien Jr., 95 N. Redemption Rock Trail, Princeton, MA 01541,
Mr. and Mrs. Elwood and Marion Taylor, 293 State Road, Otter River, MA 01436,
Ms. Wilfred Lavenski, 5 Hamlet Mill Road, Otter River, MA 01436,
American Tissue Mills of MA, In, 135 Engineers Road, Hauppauge, NY 11788,
Mr. and Mrs. Donald Faron, 72 East Street, No. Grafton, MA 01536,
Mr. and Mrs. Richard Halfrey, 3 Cottage Street, Templeton, MA 01468,

Otter River Shoreline Surveys

Letter to Tully River Abutters

November 13, 2000

Dear Neighbor of the Tully River,

You may have read in one of the local papers recently that the Montachusett Regional Planning Commission, Franklin Regional Council of Governments, Millers River Watershed Council, and citizens from fourteen watershed communities have joined together to protect and restore the Millers River. As a landowner of property along the West Branch of the Tully River and Tully River, a major tributary to the Millers River, we invite you to join us in our efforts and participate in a visual survey aimed at identifying possible non point sources of contamination.

In an effort to identify possible pollutants at their source, volunteers from fourteen communities have agreed to monitor and assess the condition of two major tributaries to the Millers River, the Otter and Tully Rivers. As a first step in this effort, volunteers will participate in a visual Shoreline Survey of the West Branch and East Branch of the Tully River and the mainstem of the Tully River as it flows to the Millers River from November 17th to December 7th. To accomplish this survey, volunteers will access the water via nearby roads and then either walk or canoe down the river, observing and recording important in-stream and land use characteristics. Care will be taken not to traverse any private property, but it may be necessary to walk along the river's banks in certain areas to avoid trampling wetland habitat.

If you have any questions or concerns regarding this Shoreline Survey Program, please contact me at (413-774-2251). To participate in the Shoreline Survey, please join us at the training session to be held on Thursday, November 16th, from 6:30 to 8:00 pm at the Millers River Environmental Center at 100 Main Street in Athol.

Thank you for your time, and we hope to work with you in the future.

Sincerely,

Joe Dunn
Natural Resource Planner

Tully River Abutters

Chester C. Carbone, 103 Cheney Street, Athol, MA 01331
Dexter Ketchen, Michele Bousquet, PO Box 247, Athol, MA 01331
Charles H. & Stella Fontaine, 236 Packard Road, Orange, MA 01364
Robert & Victoria Cortright, 196 Packard Road, Orange, MA 01364
Bruce & Tammy Suojanen, 262 Packard Road, Orange, MA 01364
William & Dion Wolfe, 204 Packard Road, Orange, MA 01364
Bryon & Donata Martin, 148 Fryeville Road, Orange, MA 01364
E.J. Connors, Jr., Inc., C/o Robert Wilkinson, PO Box 36 Hamilton, MA 01936
Christopher & Beth Ann Christiansen, 141 Fryeville Road, Orange, MA 01364
Elizabeth & Douglas Ford, 30 Tully Road, Orange, MA 01364
Franklin & Gloria Sisler, 20 Canon Lane, Orange, MA 01364
Mark & Carlene Archambeault, 30 Canon Lane, Orange, MA 01364
F&Y Realty Trust, Fern Lkawsky & Yvon Doiron, RFD No. 2 Riverdale Drive, Orange, MA 01364
Robert Franklin, 48 Canon Lane, Orange, MA 01364
Michael F. Hume, 2 Memory Lane, Orange, MA 01364
Town of Athol, Dept. Public Works, 584 Main Street, Athol, MA 01331
Jeannette M. Bowlen, 344 West Royalston Road, Athol, MA 01331
Peter & Hasanbasic Gerry Tr. Of Tully Brook Realty Trust, 379 West Royalston Road, Athol, MA 01331
Harry J. & Nellie Bates, 402 West Royalston Road, Athol, MA 01331
Dennis & Rosemary Mallett, 460 West Royalston Road, Athol, MA 01331
Joanne Moore, 500 West Royalston Road, Athol, MA 01331
Derrick J. Robideau, Kim M. Guerin, 528 West Royalston Road, Athol, Ma 011331
Mary Waters, 598 West Royalston Road, Athol, Ma 011331
Raymond Hachey, 688 West Royalston Road, Athol, Ma 011331
Robert King, 1216 West Royalston Road, Athol, Ma 011331
Columbus Assoc. Inc., C\o Fredrick Bulman, 1314 West Royalston Road, Athol, Ma 011331
Leslie & Christine Goodman, 1348 West Royalston Road, Athol, MA 01331
Joseph Hachey, 1386 West Royalston Road, Athol, Ma 011331
Pachard Heights Assoc., Attn: Pamela Smith, Treasurer, Fryeville Road, Orange, 01364
Judith and Gordon Shaw, 94 Pinedale Road, Athol, MA 01331
Charles & Rebecca Gorham, 128 Pinedale Road, Athol, MA 01331
Kenneth Benson, Sportsman Pond Road, Athol, MA 01331
Commonwealth of Massachusetts, DFEWLE, 251 Causeway Street, Suite 400, Boston, MA 02114
Paul L. Gamache, 1 Lenox Street, Athol, MA 01331
Town of Athol, 584 Main Street, Athol, MA 01331

Tully River Shoreline Surveys